RECOMMENDED DIETARY INTAKES FOR INDIANS

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INDIAN COUNCIL OF MEDICAL RESEARCH

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ON
RECOMMENDED DIETARY INTAKES FOR INDIANS

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PREFACE

The Nutrition Advisory Committee of the Indian Council of Medical Research made recommendations in 1944 on dietary allowances of energy, proteins, iron, calcium, vitamin A, thiamine , ascorbic acid and vitamin D. These recommendations were revised in 1958 in respect of energy and proteins. The Nutrition Expert Group of the Indian Council of Medical Research in 1968 made further revisions with regard to the requirements of all nutrients except energy. The last Committee made additional recommendations with regard to desirable intakes of fat, vitamin B_{12}, folic acid and vitamin D, and also for balanced diets for different groups. In making these recommendations, the Committee was guided by the safe allowances of nutrients suggested by the various expert groups of the Food and Agricultural Organization and World Health Organization and data collected on nutrient requirements for Indians.

The recommended dietary allowances require constant review and up-dating in view of the changes in our concept of human requirements. It was felt that the recommendations made in 1968 needed revision and up-dating in the light of studies carried out during this decade. The Indian Council of Medical Research, therefore, constituted a Committee to go into the available evidence and revise, if necessary, the earlier recommendations. Deliberations and recommendations of this Committee with regard to dietary intakes of nutrients by Indians, are also included here.

As compared to earlier recommendations, several important changes have been incorporated in the present recommendations.The body weights of well nourished children have been used in computing their energy and protein requirements. More realistic estimates of iron requirements based on recent observations on food iron absorption and iron turnover, have been given. In view of the observed biochemical evidence of vitamin B_6 deficiency in our population, the recommended intakes of B_6 also have been included in the new recommendations. Also, more realistic estimates of desirable fat intake are indicated.

The most important change has been with regard to the suggested balanced diets. The balanced diets have been formulated using the linear programming technique to arrive at the least-cost formulations. Use of this approach has resulted in a more realistic pattern of the balanced diets, with their nutrient content matching the recommended dietary allowance of nutrients as closely as possible. As compared to the earlier balanced diets, lower amounts of pulses and green leafy vegetables have been recommended without sacrificing the nutrient contents. It is hoped that with these changes, the balanced diets will be more acceptable.

I hope that these new recommendations will be welcomed by nutritionists, dietitians and planners to formulate menus for feeding individuals and groups and also for formulating more realistic food production strategies.

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1. INTRODUCTION

Tho Nutrition Advisory Committee of the Indian Council of Medical Research made recommendations in 1944 on dietary allowances of calories, proteins, iron, calcium, vitamin A, thiamine, ascorbic acid and vitamin D (1). These recommendations were updated in1958 in the case of calories and proteins (2). The Nutrition Expert Group of the Indian Council of Medical Research made further revisions in 1968 (3). These revisions were only partial in the case of calories, but complete in the case of proteins, calcium, iron, thiamine, riboflavin, niacin and ascorbic acid. This Committee also made recommendations with regard to desirable intakes of fat, vitamin B_{12}, folic acid and vitamin D. The basis of these recommendations have been fully discussed in the ICMR Special Report Series No. 60 (3). In making these recommendations, the Committee was guided by the dietary allowances suggested by the Expert Groups of the Food and Agricultural Organization and World Health Organization during the intervening years (4,5, 6, 7, 8) and also by the results of studies carried out in India on nutrient requirements.

In view of the changes in our concept of human requirements of several nutrients as a result of studies carried out during this decade, it was felt that the earlier recommendations of 1968 might need revision and updating. The ICMR, therefore constituted a committee to go into the available evidence and revise the earliet recommendations if required. This report includes the deliberations and recommendations of this Committee.

2. ENERGY

The body needs energy to maintain body temperature, for metabolic purposes to support growth and for physical activity. Food energy is expressed as kilo calories and calorie allowances are recommended so as to provide enough energy to promote growth in infants and children and maintain body weights in adults consistent with good health. Among factors which influence energy needs are body size, age, climate, extent of physical activity, and altered physiological states such as pregnancy and lactation.

It is most convenient to make recommendations for a 'reference man' and a 'reference woman' whose profiles are described and then to make necessary adjustments for subjects who deviate from the standard reference. This procedure was first devised by the FAO Committee on calorie requirements in 1950 (4) and has been in use ever since.

For all nutrients except energy, estimates of allowances are arrived at by determining the average i.e. mean requirement of the nutrient in question and adding to it twice the standard deviation of the mean, since this value will more than meet the reqirements of 97.5% of the population which is composed of individuals with a statistically normal distribution of requirements. For many individuals, therefore, this level will be in excess of their needs. It is considered that such excessive consumption of nutrients is not injurious to health.

In contrast, allowances for energy is the average requirement and the two standard deviation value is *not* added. This is because the energy intake and expenditure of any individual are finely balanced and any surplus energy consumption will be stored as fat and a continuous excess of intake will lead to obesity which is a well recognised health risk.

The earlier recommended dietary allowances of energy for Indians were made by ICMR in 1958 (2). These recommendations were based on available data on BMR of Indian subjects and the energy cost of different activities measured in Indians (9) as also on the recommendations made by FAO in 1957 (5). The Expert Group of the FAO/WHO in 1973 (10) revised the energy allowances downwards in view of the changes in life styles and activity pattern of adult population in developed countries.

Units of Energy

The unit of energy which has been in use in nutrition for a long time is the kilo calorie (kcal). However, recently, a replacement of this unit of energy with 'joule'

has been adopted by the International Union of Sciences and the IUNS. In this report, both units of energy have been used. These units are defined as follows ;

Kcal	=	Heat required to raise the temperature of 1 kg of water by $1^\circ C$ at $15^\circ C$.
1 Cal	=	4.184 Joule
1 K cal	=	4.184 K Joule
1000 Kcal	=	4.184 MJ
1 K Joule	=	0.239 K cal
1 MJ	=	239 K cal.

Adults

In keeping with the earlier practice, this Committee defined the energy requirements of adult man and woman in terms of a **Reference Man and Reference Woman**. After discussing the limited available data on body weights of Indian adults, the Committee tentatively agreed to continue to use body weights of 55 kg. and 45 kg. for reference man and reference woman respectively. These body weights are nearer the body weights for height reported for healthy adult populations in the west (11), than to body weights of rural adult population which are much lower (12). The following are the definitions for 'reference man' and 'reference woman'.

Reference man is between 20-39 years of age and weighs 55 kgs. He is free from diseases and physically fit for active work. On each working day he is employed for 8 hours in occupation that usually involves moderate activity. While not at work he spends 8 hours in bed, 4-6 hours sitting and moving around and two hours in walking and in active recreation or in house-hold duties.

Reference woman is between 20-39 years of age, healthy and weighs 45 kgs. She may be engaged for 8 hours in general house-hold work, in light industry or in other moderately active work. Apart from 8 hours in bed, she spends 4-6 hours sitting or moving around only through light activity and 2 hours in walking or in active recreation or in house-hold duties.

Energy expenditure of Indian reference man and women computed earlier by Patwardhan have been based on available data on BMR and energy cost of different activities by Indian subjects (2, 9). The FAO/WHO committee of 1973 have made a downward revision in energy expended during the eight hours of non-occupational work, because of changes in life style in developed countries. The committee discussed this recommendation of the FAO/WHO expert group (10) and found no evidence that this was applicable to Indian subjects, to justify a reduction in the allowances for energy recommended earlier (2) and suggested the retention of the 1968 figures.

TABLE 2.1

ENERGY ALLOWANCE FOR ADULTS

Category	Reference body weight Kg.	Activity	Energy allowance Kcal	Mj
Man	55	Light	2400	10.00
		Moderate	2800	11.70
		Heavy	3900	16.30
Woman	45	Light	1900	7.95
		Moderate	2200	9.20
		Heavy	3000	13.10

TABLE 2.2

THE EFFECTS OF BODY WEIGHT ON ENERGY REQUIREMENTS OF MEN & WOMEN ENGAGED IN MODERATE ACTIVITIES

Body Weight	Men	Women
35	—	1711
40	2036	1955
45	2290	2200
50	2545	2444
55	2800	2688
60	3054	2933
65	3309	3177
70	3063	3422

Pregnancy

During pregnancy additional energy is neended to support the growth of the foetus, placenta and maternal tissues as well as to meet the increased metabolic rate (BMR). BMR increases by about 5% during the first and second trimester and by about 12% during the third trimester (13).

The total energy cost of pregnancy for a reference woman weighing 58 kgs. has been estimated to be 80,000 kcals (14). Of this, about 36,000 kcals is deposited as fat

which is subsequently utilised during lactation. Based upon these estimates the FAO/WHO Expert Group (10) recommended an extra daily allowance of 150 kcals during the first trimester and 250 kcals during the rest of pregnancy. A recent direct estimate of energy expenditure during normal pregnancy and indirect calorimetry has shown that this is around 27,000 kcals (16). For a reference Indian woman, whose body weight is 45 kg. the total energy cost of pregnancy on this basis, would be approximately 62,500 kcals and the energy expenditure during normal pregnancy would be 20,900 kcals. The additional daily requirement to meet the increased energy expenditure would thus be about 120 kcals during the second and third trimesters of pregnancy. This, level however, would not allow for the deposition of fat, which during lactation is used to meet the additional energy needs. The earlier ICMR recommendations made in 1968 (3) suggested an additional energy allowance of 300 kcal/day during pregnancy. Pregnant women of low income group in India not do normally increase their food intake during pregnancy. Experimental evidence both from India and outside India have demonstrated the beneficial effects of energy supplementation to such woman on birth weights of infants (16, 17). On the basis of this evidence, the Committee felt that extra energy intake is desirable not only for the growth of foetus and maternal tissue, but also for the deposition of fat which can be utilized for meeting the increased energy demand during lactation. The period of pregnancy during which the additional energy must be provided was discussed and it was recommended that it should be given during the second and third trimester. The present Committee therefore recommended an additional intake of 300 kcal/day during the second and third trimester.

Lactation

Additional energy required during lactation is computed from the volume of milk secreted, its energy content and the efficiency of conversion of food energy into milk energy. Estimates of additional energy needs during lactation of the recent FAO/WHO Expert Group (10) is based on a milk output of 850 ml. and efficiency of conversion of 80 per cent. On the basis of this computation, the additional intake of energy recommended during the first 6 months of lactation is 550 kcal/day. In this computation, the contribution of fat deposited during pregnancy is also taken into account.

Additional intake of energy recommended during lactation by ICMR in 1968 (3) was 700 kcal of which 500 kcal was for milk secretion based on milk output of 600 ml/day and 200 kcal for increased BMR. In the light of later evidence (13), an allowance of 200 kcal for increased BMR does not seem to be appropriate. Also, energy allowances must be made for secretion of optimal amounts of milk, i.e. 850 ml. rather than 600 ml. On the basis of secretion of 850 ml of milk and 80 per cent of efficiency of conversion of dietary energy into milk energy and taking into account the contribution of energy from fat stores built up during pregnancy, it was recommended that additional energy allowance during lactation must be 500 kcal/day for the first 6 months. Since Indian woman continue to lactate beyond 6 months, albeit with reduced milk output, upto one year, an extra allowance of 400 kcal/day was recommended for periods rom 6 months to 1 year.

TABLE 2.3

ADDITIONAL ENERGY ALLOWANCE DURING PREGNANCY AND LACTATION

period		Energy allowance Kcal/day	Mj/day
Pregnancy	2nd & 3rd trimester	300	1.25
Lactation	First 6 months	550	2.3
	6—12 months	400	1.68

Infants

The FAO/WHO recommendations of energy intake of infants (10) are based on energy intake of normally growing infants fed breast milk *ad lib.* The present Committee recommended the use of the same set of figures for energy intake by infants suggested by the FAO/WHO Committee in 1973 (10) for Indian infants also. It was emphasized, however, that these allowances are in the nature of guidelines for feeding infants who for various reasons cannot receive breast milk. The quantity of breast milk needed to meet these levels of energy would be 850 ml up to three months of age and 1,200 ml between three and six months of age. The average breast milk output in Indian women belonging to poor income groups are much lower than these, although their infants grow satisfactorily up to atleast 4 months of age. It was, however, considered possible that these figures may be an under-estimate of actual intake because of infrequent sampling and also due to shortcomings of test feeding technique employed to determine intake.

TABLE 2.4

ENERGY ALLOWANCE FOR INFANTS

Age	Kcal per Kg.	Kj per Kg.
∠ 3 months	120	500
3 - 5 months	115	480
6 - 8 months	110	460
9 - 11 months	105	440
Average during 1 st year	112	470

Children

In the absence of any data on energy intake of normally growing healthy Indian children, the Committee recommended the adoption of energy allowances recommended by FAO/WHO in 1973 (10) with necessary adjustments for the body weights of healthy well nourished Indian children. For this purpose, the Committee recommended, the

use of body weights of healthy children, who had no constraints of any nature and who could express their full genetic potential for growth (18). The Committee also examined the limited data available on the energy intakes of such children (19). It was observed that the actual measured energy intakes of such children corresponded closely to the intakes recommended at present.

The question of applicability of these figures to large numbers of Indian children who are undernourished and underweight was discussed. Based on the available evidence on the benefical effects of energy supplementation on the growth of such children (20), the Committee suggested that providing energy on the basis of ideal weight for age would be beneficial. The fears about the possible over-estimation of energy deficiency in a community using these recommended figures were however, expressed. It was, therefore, suggested that a brief note be appended for the practical use of recommended energy allowances.

TABLE 2.5

ENERGY ALLOWANCE FOR CHILDREN

Age group	Body weight* Kg.	Energy allowance Kcal	Mj
Children			
1—3 Years	12.03	1220	5.1
4—6 ,,	18.87	1720	7.2
7—9 ,,	26.37	2050	8.6
Males			
10—12 ,,	34.30	2420	10.1
13—15 ,,	47.03	2660	11.1
16—18 ,,	56.50	2820	11.7
Females			
10—12 ,,	36.47	2260	9.5
13—15 ,,	45.53	2300	9.6
16 18 ,,	50.00	2200	9.2

* Actual weights of well-to-do children from Public Schools.

Activity

An important factor which determines energy needs is the nature and duration of physical activity—whether moderate or heavy. For those whose occupation entails heavy

work, allowances have to be higher than for those who are either sedentary or engaged in moderate work. The allowances are made under the assumption that the energy expenditure for non-occupational activities remains unchanged. Energy requirements suggested for different activities for adults was the same as recommended earlier by ICMR in 1968. These are given in Table 2.1.

Climate

Other factors being equal, the energy cost of work is slightly higher when the temperature falls below 14°C. Also, heavy clothing when worn will tend to marginally raise energy needs. On the other hand, physical activity usually is curtailed to some extent at low temperatures.

The present estimatess of energy requirement of Indians have been made under prevailing environmental temperature in the country. Also, since man suitably modifies his micro-enviroment to protect himself against changing external temperature the Committee felt that there was no need to make any adjustments for temperature.

Age

Energy requirements decline progressively after early adulthood, partly because of a reduction in BMR and partly because of curtailment of physical activity. While the extent of reduction of BMR has been quantitated, that due to lowered physical activity has neither been documented nor has it been found to be uniform. Any adjustments for age would, therefore be arbitrary. The energy expenditure by moderately active individuals at different ages is given in Table 2.6. The Committee recommended that adjustments for age proposed by FAO/WHO Expert Group (10) could be adopted for Indians.

TABLE 2.6

AVERAGE ENERGY REQUIREMENT OF MODERATELY ACTIVE ADULTS OF REFERENCE BODY WEIGHT AT DIFFERENT AGES

Age Years	55 Kg Man	45 Kg Woman	% of reference
20-39	2800	2200	100
40-49	2660	2090	95
50-59	2520	1980	90
60-69	2240	1760	80
70-79	1960	1540	70

Guidelines for the practical use of energy allowance

Recommended energy allowance values must be used with caution for estimating the extent of energy deficiency among population groups. The energy requirement is based on measurements of intakes in healthy active individuals and are defined separately

for each of the various age and sex groups and for each specified level of activity. These figures are estimates of the average needs for the recommened allowances for individuals.

It is therefore to be expected that in any healthy active population of a specified category, half the individuals will be able to meet their requirements with intakes less then the average, and the other half with more than the average. The coefficient of intake is estimated to be 15 per cent and this includes both intra-and inter-individual variation. It has been observed that intra-individual variation accounts for almost the whole of the total variance observed within the same age, sex-group and category. Even on a conservative basis therefore, an individual in a specified category will be able to meet his requirement of intake ranging from mean-minus 25 per cent to mean-plus 25 per cent. In the light of these considerations, an individual eating less than the average requirement cannot be regarded as undernourished or one eating above the average requirement as overnourished, unless such intakes result either in a decrease or an increase in body weight over prolonged periods. While estimating the incidence of energy deficiency among populations based on their intakes, the point of reference should not therefore be the average requirement, but the lower limit arising from intra-individual variation, viz. mean-minus 2 times the standard deviation or 25 per cent below the average requirement.

3. PROTEINS

Dietary protein is necessary not only to provide amino acids but also nitrogen for the synthesis of body proteins and other biologically important nitrogenous constituents, all of which are turned over continuously in the body. Eight (nine in the case of infants) of the twenty amino acids present in his tissues cannot be synthesised by man and these have to be provided through food. They are, therefore, called 'essential' amino acids and from the nutrition stand point form the critical components of dietary protein.

When placed on a protein free diet, subjects lose some nitrogen from the body, through urine, feces, sweat, and skin—collectively known as endogenous loss or obligatory loss of nitrogen. In the adult, amount of dietary protein which is needed to replace the endogenous loss is considered to be the minimum protein requirement for maintenance. Growing children and pregnant and lacting women need additional protein to meet their increased needs.

There are two basic approaches to the determination of protein requirements. The first is based upon the factorial methods, wherein endogenous losses are measured and the second is based upon the actual estimation of the lowest amounts of nitrogen intake necessary to maintain nitrogen equilbirium. Estimates of the minimum amount of protein needed for maintaining N equilibrium in adults are generally higher than those obtained by the factorial approach. This observation has, in fact, been taken into consideration by the FAO/WHO Expert Group (10)and data obtained from N balance studies have formed the basis of their recommendations.

Food proteins differ in their nutritional quality, depending upon their amino acid content, amino acid profile and digestibility. There are several methods by which the quality of a protein in a food can be determined. It is now recognised that although this provides useful information, it does not provide information on the protein quality of the complex human diets as they are consumed. This information is critical for translating protein requirements into recommended dietary allowances. The amino acid patterns of two different foods when consumed together may often complement each other, thus improving the protein quality of the diet. It is for this reason that the efficiency with which dietary proteins are utilized has to be determind. Milk or egg protein is considered 100% efficient and proteins from

other food sources are evaluated in terms of either of these two proteins. Protein requirements are expressed in terms of egg or milk protein and converted into recommended dietary allowances by making necessary adjustments for the protein quality of the diet.

It is customary to express protein requirements in terms of body weight. In defining human protein requirements, it is tacitly understood that the diet is adequate with respect to other nutrients particularly energy, in view of the well known close metabolic interrelationship between energy and protein. In the face of energy inadequacy, some of the protein would be used for purposes of providing energy and will not be available for the synthesis of body protein. Also, when energy intake is low, the efficiency with which protein is utilized decreases.

Dietary protein allowances for Indians was first recommended in 1944 (1) and the figures were revised in 1958 (2) and again in 1968 (3). The 1968 recommendations made after the FAO/WHO recommendations of 1965 were based to a large extent on the factorial approach advocated by the FAO/WHO Committee (6). In 1973, the Joint FAO/WHO Expert Group (10) on energy and protein requirments, revised the 1965 recommendations in the light of newer knowledgs gained during the intervening years and also on the experience of the practical application of the 1965 recommendations. In the light of this newer developments and some studies on protein requirements of Indians carried out in recent years, the Committee recommended protein allowances as indicated below :

Adults

The ICMR Nutrition Expert Group in 1968 (3) had recommenned 1.0 g protein/kg body weight for an Indian adult, the protein being derived from mixed vegetable source. The present Committee considered the basis on which the revised estimate of protein requirements were made by the 1973 FAO/WHO Expert Group (10). A value of 2 mg N per basal calorie has been suggested as representing obligatory N losses. This is composed of losses in urine, faces, sweat and the integument. Results of studies carried out on Indian subjects have shown that while the loss of N in urine is essentially similar to that found by workers in other parts of the world, fecal losses are somewhat higher (21–24). Although the amount of N lost through sweat, tears, hair, nails and skin is very small, it cannot be considered as being negligible. There is reason to believe that loss of N through sweat in a tropical country such as ours will be higher than that countries with a temperate climate, and daily N loss through sweat in Indian subjects has been estimated to be 0.32 (26) and 0.5 g/day (27). Data on other cutaneous losses are meagre. On the basis of available information, it would be appropriate to use a figure of 2.5 mg/basal calorie as endogenous N losses of the Indian adult.

There is some information on the biological value and digestibility of Indian diets which are predominantly based on foods of vegetable origin (21.25). The net protein utilization (NPU) calculated from these data is around 50%. These

values are for intakes higher than the minimum required for maintaining nitrogen balance and it is known that NPU is better at lower levels of protein intake. Data available from studies carried out in India using low levels of protein have indicated that the NPU is anywhere between 50 and 80 depending upon the sources of dietary protein. It was considered reasonable to assume that a value of 65 represents the mean figure for proteins of different qualities present in the wide range of diets habitually consumed in India, although some of the dietary proteins may have relative value higher than this. Dietary protein allowances computed by the factorial method using the value of 2.5 mg/basal calorie as the obligatory N loss and a value of 65 as NPU relative to egg works out to 1.0 g protein/kg. body weight, a figure close to that derived from N balance data (21, 29, 30). The Committee, therefore, recommended the retention of the figure of 1.0g/kg made earlier(Table3.1).

TABLE 3.1

PROTEIN ALLOWANCE FOR ADULTS **

	Body weight Kg.	Activity	Protein allowance* g/kg/day	g/day
Man	55		1.00	55
Woman	45		1.00	45

* Protein of mixed vegetable origin with NPU 65 relative to egg.

** Computed factorially using 2.5 mg, N/basal Cal as obligatory N.

The estimates of nitrogen losses and the amount of nitrogen needed to maintain balance have a co-efficient of variation in the same individual from day to day.The figure of 1.0g/kg.body weight includes a 30%addition to cover this variability.

Infants

Protein allowances for infants should meet the needs not only for maintenance but also for the rapid growth which occurs during the first year of life. Experimental studies designed to determine protein requirements of infants are scanty. Allowances for protein can, however, be computed from a knowledge of the protein content of breast milk and the volume of milk consumed by healthy infants whose growth rates are normal. Protein intake of satisfactorily growing Indian infants was found to be 2.0 g/Kg. during the first two weeks, which fell to around 1.1 g/kg. at 94 weeks (31)—values essentially similar to those recommended by the FAO/WHO Expert Group in terms of milk protein. For infants beyond the sixth month, breast milk alone will not be able to satisfy protein needs and supplementary foods have to be given. Since infants in India may be given food supplements based on vegetable proteins, it was recommended that protein allowances for

infants between and 12 months of age may be made in terms of both breast milk protein and vegetable proteins, each contributing equally to total protein intake. The recommended protein allowances for infants are given in Table 3.2

TABLE 3.2

PROTEIN ALLOWANCES FOR INFANTS

Age	Protein allowance per day g/Kg
0 – 3 months	1.3 [a]
3 – 6 months	1.8 [a]
6 – 9 months	1.8 [b]
9 – 12 months	1.5 [b]

a. In terms of milk proteins alone.

b. In terms of equal proportions of milk proteins and vegetable protein supplement with relative NPU of 65.

Children

As in the case of infants, studies on children wherein direct measurements of protein requirements have been made are very few. Their requirements have been computed by the factorial method. Recent published data indicate that obligatory loss of urinary N in children per basal calorie is lower than that seen in adults (32) and available evidence suggests that the total endogenous loss may be nearer 2 mg/N/kg. body weight. Using this figure and a relative protein value of 65, protein allowances have been calculated. The Committee considered the limited data (33) obtained through N balance studies in apparently healthy pre-school children belonging to the low income groups, who however, had body weights which were lower than those of children belonging to the well to do groups. Though it was felt that values for protein requirement determined in them may not be completely valid for children with normal body weight,it was considered significant, that experimentally obtained figures were essentially similar to computed values. Available data on body weight of Indian children mostly relate to children coming from poor socioeconomic groups, wherein environmental factors may not have have permitted the expression of the full genetic potential for growth. Limited data collected in recent years on children belonging to communities wherein there are no constraints for growth have in fact confirmed this and they indicate that well nourished pre-school children can attain heights and weights very close to those reported in the west (18). The question as to whether allowances for dietary protein should be made on the basis of existing body weight or on the expected weight for age is not easy to answer. To calculate the daily allowance of protein, weights in

between actual and ideal were used earlier.This Committee recommended that tota daily allowance be computed on the basis of body weights seen in normaly growing well-to-do children as was done in the case of energy. The figures for daily intake are given in Table 3.3.

TABLE 3.3

PROTEIN ALLOWANCES FOR CHILDREN

Age group	Body weight [a] Kg.	Protein allowance [b] g/kg/day	g/day
Children			
1—3 Years	12.03	1.83	22
4—6 ,,	18.87	1.56	29
7—9 ,,	26.37	1.35	36
Males			
10—12 ,,	34.30	1.24	43
13—15 ,,	47.03	1.10	52
16—18 ,,	56.50	0.94	53
Females			
10—12 ,,	36.47	1.17	43
13—15 ,,	45.53	0.95	43
16—18 ,,	50.00	0.88	44

a. Body weights of well-to-do children from public schools.

b. In terms of mixed vegetable protein of NPU 65 relative to egg.

Pregnancy and Lactation

Allowances for pregnant women must cover the additional needs for the development of the foetus, placenta and accessory maternal tissues, while those of actating women must cover what is secreted into milk. Results of nitrogen balance studies carried out in pregnant (34) and lactating women (35) of the low income group have shown that they retained considerable amounts of nitrogen and that retention increased upto intakes of 85 g protein per day in pregnant women and upto 100 g protein per day in lactating women. If the level of protein intake at which maximum N retention occurs is considered as the requirement, corresponding figures for pregnancy and lactation would be 85 g and 100 g respectively. However, the extent to which pregnancy and lactation *per se* and their erstwhile nutritional status had contributed to these apparently high values is not clear.

The use of these N retention data to calculate protein allowances in these two physiological states may, therefore, not be valid and desirable. Protein requirements in pregnancy can also be calculated on the basis of the N content of the products of conception and N needed for expansion on maternal tissues. While there are data on these aspects in Western women (14), there is very little information on well nourished Indian subjects. Since the gain in body weight during pregnancy of well nourished Indian subjects is not different from that of Wessern women, figures suggested for Western subjects may be accepted for Indian subjects also. Adoption of figures for the additional requirements suggested by the FAO/WHO Expert Group with adjustments for dietary protein quality (65 NPU) would place the value at 14 g/day.

The average protein content of breast milk of Indian women is 1.2 g/dl(35). The efficiency of conversion of dietary protein is not known and it is generally assumed that protein is used for milk protein synthesis as efficiently as for body protein synthesis. The Committee recommended that an average milk volume of 859 ml and a NPU of 65 be used to compute the additional protein needs for lactation. Protein allowances for pregnancy and lactation are given in Table 3.4

TABLE 3.4

ADDITIONAL PROTEIN ALLOWANCE DURING PREGNANCY AND LACTATION

Period	Duration	Protein allowance g/day
Pregnancy	2nd & 3rd trimester	14
Lactation	0—6 months	25

* In terms of mixed vegetable protein of relative NPU of 65 NPU.

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4. FATS

Dietary fats are important from the nutrition standpoint for several reasons. They are concentrated sources of energy providing as they do 9kcal/g, serve as vehicles for fat soluble vitamins, are structural components of cell and cell memberanes, and are sources of essential fatty acids (EFA). Two polyunsaturated fatty acids–linoleic acid and arachidonic acid are essential for nutritional well being; of the two, linoleic acid cannot he synthesised by the body and has, therefore, to be provided through the diet. Arachidonic acid, however can be synthesized from linoleic acid in mammalian tissues. These two unsaturated fatty acids are the precursors of prostaglandins which are required for a wide variety of metabolic functions. Apart from their nutrtional significance, fats improve the palatability of diet, delay gastric emptying and raise the caloric density.

Deficiency of essential fatty acids is known to occur in infants and young children and follicular hyperkeratosis (phrynoderma) is believed to be a clinical manifestation of essential fatty acid deficiency in man (37, 38). However requirements of EFA cannot be computed from studies on phrynoderma since B–complex deficiency coexists in most of such subjects and there is evidence to show that administration of B–complex alone can sometimes cure the condition (39, 40).

Average Fat Intakes

In developed countries, dietary fats provide from 30 to 40% of total energy consumed. Affluence causes an upward trend in fat consumpsion. An unusual situation is that of Eskimos whose diets provide almost half the total energy through fat without any apparent ill effect.

Developing countries show wide variations in fat intake. In India, where low income and economically deprived groups whose diets provide about 1300-1500 calories, ferequently include no visible fat at all. The unseen or invisible fats however, present in almost every article of food such as cereals, tubers, pulses, vegetables, oileseeds, milk and all flesh foods, provides. about 8–9 % energy of the diet (4,1). Affluent groups derive a similar percentage of energy intake from invisible fat, but in addition, consume about 50-70g/per day of visible fat(4,1). Together they provide about 30% of dietary energy.

High fat diets permit the consumption of high levels of energy needed for sustained high workloads without unduly increasing bulk. On, more usual work regimens, it seems to matter little whether energy is derived from fat or from carbohydrate. The consumption of high-fat diets (30-35% energy), as is now prevalent in advanced countries, especially when poor in polyunsaturated fatty acids and when associated with other stresses of modern living, appear to be associated with an increased risk of ischaemic heart disease.

Recommendations for Fats

The optimum quantity of fat that has to be included in the daily diet is not known with any degree of certainty. However, based upon existing evidence on the nutritional aspects of dietary fat and the undesirable effects of high fat intake, the following intakes of fat may be suggested as being desirable.

Adults

In the diets of adults in India, about 20% energy may usefully be derived from fats. At all levels of calorie intake, invisible fats furnish about 9% energy. The rest i.e., about 10% energy may be met from visible fats per day. This would come to 10 to 20 g. of fat per day depending upon the level of calories consumed.

In habitual diets in our country, which are cereal–legume based, about half the invisible fat (4.5 – 5% energy) will be composed of linoleic acid. Although there is considerable controversy about EFA requirements, the Expert FAO/WHO Consultation Committee (42) has placed it at 3% energy. It has also been deduced to be 5 g/day (39,3). This requirement can be met even by the invisible fat component of existing Indian diets (41). Since several dietary components such as saturated fatty acids, cis–monosaturated acids, proteins and cholesterol can increase EFA requirement, it would appear prudent to choose the visible or cooking fat from such unsaturated vegetable oils as the following (the average linoleic acid percentage of each being shown as follows) : safflower 65, sunflower 60, sesame 45, cottonseed 50, and groundnut 20.

Pregnancy and Lactation

There are no studies on EFA requirements during pregnancy and lactation. The additional needs for the expansion of maternal tissues as well as for the foetus have to be met from the maternal diet. The fat in foetal organs, especially the liver and brain contains phospholipids rich in EFA. It is desirable, therefore, that diets during pregnancy provide 4.5% energy through EFA. These levels can be met by existing habitual diets.

Breast milk secreted during a day contains between 3 and 5 g. of EFA (41, 43). The efficiency of conversion of dietary EFA to milk EFA is not known.

Because of these considerations, a level of 6% energy through EFA is recommended. The use of vegetable fats rich in polyunsaturated fatty acids acquires importance in this context.

Infants

The use of breast milk in which 50–60% energy comes from fat (about 25–27 g/day) is strongly to be encouraged. Foods which are used as substitutes when breast milk is not available should ensure this high proportion of fat, and the choice of this fat should be such that 5–6% energy is in the form of EFA and a further 1% energy as higher unsaturated fatty acids of the linoleic and linolenic series, as is the case in the fat of human milk.

Weaning diets should provide about 25% energy as fat, primarily to reduce bulk. Use of excessive visible fat may endanger the calorie protein balance and hence a blend of 10% energy of invisible fat with 15% energy (or about 17 g/day) of visible fat should be aimed at.

Suggested levels of fat intake are given in Table 4.1.

TABLE 4.1

SUGGESTED INTAKES OF DIETARY FAT

	Fat (energy percent)	Essential fatty acid (energy percent)
Adults : Man & Woman	20*	3
Pregnant Woman	—	4.5
Lactating Mother	—	6
Infants	—	6
Young Children	25	5–6

*About half of this i. e., 10% will come from invisible fat present in the foods.

5. IRON

Iron is an important constituent of haemoglobin, myoglobin and several enzymes. The human body contains between 3 and 4 g of iron of which about 70% is present as circulating iron and the rest as storage iron. Consumption of diets which do not provide enough iron leads at first to a progressive depletion of storage iron and only later do levels of haemoglobin fall leading to anaemia. Anaemia, therefore, is not an early manifestation of iron deficiency. Iron deficiency without anaemia can frequently occur.

Iron is, in a way unique since once it has entered the body, there is no physiological mechanism by which it can be eliminated and its concentration regulated. Losses of iron that occur are entirely through desquamation of cells which contain iron and through loss of blood. Iron metabolism is, therefore, regulated at the level of intestinal absorption either to prevent iron overload or to compensate for inadequate stores. Apart from this physiological regulation, iron absorption is influenced by the chemical nature of dietary iron as also by a variety of dietary factors some of which promote absorption and some others which inhibit absorption.

The question of dietary allowances for Indian subjects assumes special importance in the context of widespread prevalence of iron deficiency anaemia in our country. It is particularly widespread among women of the child bearing age and children of preschool age. Results of several diet surveys in India have shown that the mean intake of dietary iron is around 30mg a day and that the iron intake is related to energy intake. Only 6% of families studied had intakes below 15 mg/day and 10% below 20 mg/day. The widespread anaemia in this context, therefore strongly suggests that factors other than low intakes of iron are concerned with the development of iron deficiency anaemia. These may be due to either excessive iron loss or very poor bioavailability of dietary iron or both.

The Nutrition Expert Group of the ICMR (3) recommended in 1968 dietary allowances for iron for different groups based upon estimates of iron losses that had been determined in Indian subjects and absorption of dietary iron from habitual Indian diets determined by the chemical balance technique. The basis of these recommendations have been fully discussed earlier (3) .

Iron Requirements in Normal Men and Women

The Committee reexamined the available evidence on the physiogical losses of iron in men and women. In men physiological losses of iron occur through sweat, urine and the desquamation of iron containing cells in the gastrointestinal tract. In women, in addition to these losses, iron is lost through menstrual blood. Physiological losses of iron through gastrointestinal tract, urine and skin in normal men and women have been found to be between 12 and 15 μg per kg body weight/day (44). These estimates have been based essentially on the results of turnover studies carried over long periods of time in adult men. Calculated for a reference man of 55 kg and a reference woman of 45 kg, the daily losses would be 0.7 mg and 0.6 mg a day respectively. Based upon studies in human volunteers, the dermal losses of sweat in Indian subjects has been computed to be be tween 0.58 and 3.22 mg/day (45, 46). The group reviewed other available reports on iron losses through sweat and felt that these figures appear to be overestimates. Using more reliable methods involving the turnover of radio labelled iron, it has been found that iron losses through sweat in subjects engaged in moderate activity in temperate climates in America were not different from those in Indian subjects working in hot humid conditions, in South Africa or from those in Mestizos engaged in heavy manual labour in Venezuela (44). The earlier ICMR committee had used a figure of 2 mg a day for basal loss of iron in man, a considerable proportion of which was contributed by sweat loss. These figures were arrived at by collecting sweat from volunteers under thermal stimulation for a short period of time, determining the iron content chemically and making some projections for whole body losses for a 24 hour period (45, 46). In the light of more recent studies, these estimates appear to be excessive.

Iron losses through menstruation in women of reproductive age groups are 0.6 mg per day on an average, when spread over the whole month (47, 48, 49). The distribution of menstrual loss of blood in the population indicates that about 10–20% of women lose over 1 mg iron/day. For computing iron requirements of women it was recommended that iron losses through menstrual blood in women in the reproductive age be considered as 1 mg/day.

Pregnancy

Iron requirements during pregnancy can be calculated from a knowledge of the iron needs for foetal growth, expansion of maternal tissues including the red cell mass, the content of iron in the placenta and the blood lost during parturition, and adding these to the requirements of a non-pregnant, non-menstruating woman. Data on the extent of increase in circulating haemoglobin in well-to-do Indian pregnant women are scanty. However, for a woman weighing 45 kg, the amount of iron needed to generate additional haemoglobin would be approximately 400 mg. It may be pointed out however, that this amount is not lost from the body, since following parturation, this is returned to the stores. Analysis of

foetesus born to women belonging to the poor income groups in India has shown that the iron content varies from 112 and 240 mg, with a mean of 204 mg (49)—a value lower than the mean value of 270 mg in wellnourished Western infants (50). Among reasons for the lower value in Indian foetesus are the lower foetal weights and lower iron stores in the foetus due to maternal iron deficiency. The mean loss of iron through the placenta and blood during parturition in Indian women is about 90 mg (49). The total iron needs during pregnancy including the basal loss of 0.6 mg/day, thus, comes to approximately 3.4 mg/day.

Lactation

In addition to basal losses, during lactation, iron is lost through breast milk. The concentration of iron in breast milk is about 0.12 mg/dl (51). On the basis of an output of 850 ml of milk per day, about 1 mg of iron would be lost through milk. Because of lactational amenorrhoea, 1 mg of iron which would have otherwise been lost, is saved and this would compensate for the iron loss through milk. Because of this reason, there appears to be no need to recommend additional allowances for lactation over that of a non-lactating non-pregnant subject.

Iron Loss in Infants and Children

Losses of iron in infants and children are not precisely known and amounts needed to replace these losses are, therefore, difficult to determine. During growth, for an increse in each kg in body weight 30 mg of iron is required and since the increase in body weight during childhood is 2 kg/year on an avegrage, the daily requirements of iron for growth will be 0.2 mg The physiological requirement can vary markedly for 1–2 years from 0.2 – 0.5 mg/day. Taking into account the need for growth, the daily requirement of iron of an infant, was computed to be 0.36 – 0.66 mg/day.

Recommended Dietary Intake of Iron

Recommended intake of iron is calculated on the basis of iron loss (requirement) and iron absorbed from diets commonly consumed in India. Earlier studies using the chemical balance technique had indicated that iron absorption from composite meals could be around 10%–(52, 53, 54) a value employed earlier (3) to compute dietary allowances of iron for Indians. However, results of several recent studies using more accurate istopic techniques have shown that the mean absorption of iron from Indian diets is around 3% in man and about 5% in women (55). Also, available evidence indicates that iron absorption during pregnancy is considerably higher than that in normal women (56). For the purpose of computing dietary allowance of iron during pregnancy, it was considered that the absorprion of dietary iron from Indian diets would be around 8%.

Recommended dietary intakes of iron for different groups are given in Table 5.1.

TABLE 5.1

RECOMENDED DIETARY INTAKES OF IRON

Group	Body wt (kg)	Iron requirements mg/day	Dietary intake mg/day
Adult :			
Man	55	0.72	24 [a]
Woman	45	1.6	32 [b]
Pregnancy		3.4	40 [c]
Lactation			32 [b]
Infants		1.0 mg/Kg.	
Children		0.65	20–25 [a]
Adolescent Boys			25
Girls			35

a. absorption 3%, b. absorption 5%; c. absorption 8%.

The results of several studies done in India have shown that in diets which are predominantly based upon cereals, the high phytate content interferes with iron absorption (52,53) and that iron absorption could be improved by the addition of calcium to such diets (57). Ascorbic acid has also shown to improve dietary iron absorption (54). Results of more recent studies have shown that food tannins may also render food iron unavailable for absorption (58). The diets of large segments of the Indian population not only contain high amounts of phytate and tannin but also are poor in calcium and ascorbic acid — a situation which would lead to poor absorption of dietary iron and thus explain the widespread iron deficiency in spite of seemingly high intakes of iron.

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6. CALCIUM

Most of the calcium in the body is present in the skeleton and an adult man weighing 55kg would approximately have 950g of the mineral. The amount of non-skeletal calcium is very small, but has an important role in neuromuscular excitability, blood coagulation, and membrane permeability. In the adult, dietary calcium is needed to replace endogenous losses of calcium through urine, sweat and bile.

The Nutrition Advisory Committee of the ICMR (1) had recommended in 1944 a daily allowance of 1 g/day for an adult, 1.5 g for pregnant women, 2 g for lactating women and between 1 and 1.5 g for children. Large sections of the world's population live on diets which provide amounts of calcium well below these figures without any apparent ill effects due to calcium deficiency. Long-term balance studies in man have shown that calcium balance can be achieved at intakes of calcium at 300 to500 mg a day (59,60,61). It has also been observed that body can adjust to wide variations in calcium intakes. Based on these observations, the FAO/WHO Expert Group (7) has recommended practical allowances for calcium for different groups which are only half of those accepted earlier.

Results of diet surveys carried out in India show that the intake of calcium varies widely from one region to another (370 to 1100 mg) with a mean of 550 mg/day and that the intake in predominantly rice eating population is even lower (62). Most of this calcium comes from cereals and other foods of vegetable origin;the availability of which may be limited by associated factors such as oxalic acid and phytates. Analysis of some skeletons of Indian subjects has shown that the calcium content of these bones was normal (63). Results of several balance studies in Indian subjects have shown that positive balance could be achived with intakes ranging from 177 to 448 mg/day (64–,65). In an individual accustomed to a high intake of calcium, a sudden reduction in intake may lead to negative calcium balance, as it happens–in short term balance studies, but continued low levels of intake results in adaptation and restoration of balance. Among other dietary factors which appear to be important for calcium balance is the level of dietary protein. There appears to be a relationship between level of protein intake and urinary excretion of calcium–the excretion increasing with increasing levels of protein intake (69). The extent to which this modifies calcium requirements and its nutritional significance in the

context of widespread osteoporosis among population groups whose habitual diets provide more than the recommended allowance of protein need further study.

Pregnancy and Lactation

The amount of calcium in a full grown foetus is between 25 and 30 g. And most of this is deposited during the third trimester.This corresponds to about 250 to 300 mg Ca/day during the last 100 days of pregnancy and has to come from maternal stores. There is, however, evidence to show that during pregnancy particularly the second half, calcium retention improves (70), indicating that atleast part of the increased needs during pregnancy is met by better retention of ingested calcium.

The calcium content of breast milk of Indian mothers varies between 30 and 40 mg/100 ml. (51) and the total amount of calcium lost through milk is about 300 mg/day. It would appear, therefore, that both in pregnancy and in lactation, additional intakes of calcium are necessary so as to enable the additional retention of 300 mg. of calcium daily. The level of calcium intake which would result in such retention is not exactly known. An intake of about 1 g Ca daily may be expected to cover the calcium needs of pregnant and lactating women.

Infants and Children

The calcium requirements of young infants can be computed from calcium intakes through breast milk of healthy infants who are solely breastfed. On this basis, upto six months of life, calcium intakes of about 300 mg daily would be adequate.

TABLE–6.1

SUGGESTED DIETARY INTAKE OF CALCIUM

Age Group		Mg/day
Adults		
Man		400–500
Woman		
Pregnancy and Lactation		1000
Infants		500–600
Children	1–9 Years	400–500
	10–15 Years	600–700
	16–19 Years	500–600

Calcium requirements of children can be calculated on the basis of the amount of calcium accretion during the period of growth. This can be computed from a knowledge of the calcium content of the infant at birth and of an adult. An adult weighing 55 kg accumalates approximately 950 g of calcium in his skeleton, over a period of 18 to 20 years which represents a daily average of 150 mg. This deposition is not uniform throughout the growing period, but would be relatively greater during early chilhood and during adolescence than during the other periods of growth. Data on calcium balance at varying periods of growth in children is scanty. Positive balance of 120 mg/day has been found in 10-11 year old Indian children at daily dietary intakes of 350 mg (71). In the absence of defenite data on calcium requirements of Indian children at various age groups and in the absence of data on the extent of absorption of calcium from diets at different time points of growth, the Committee recommended that dietary allowances of 0.5 g suggested earlier may be used (3).

7. VITAMINS

Vitamins are essential for the maintenance of normal health. Although needed in very small amounts,they play an important role in the metabolism ofseveral nutrients. Clinical manifestations due to vitamin deficiencies have long been recognised. There are considerable interactions between the various vitamins; in addition, vitamins and harmones interact closely. Although some of the vitamins are synthe-ised by the microflora present in the human intestnies—particularly the large gut, the extent to which they are available to the host is uncertain. Vitamin requirements therefore, have to be met through dietary sources.

There are several ways by which vitamin requirements can be determined.One of the rough methods has been the assessment of dietary intakes of vitamins by apparently normal healthy subjects and by subjects who show evidence of deficiency and detrmine the level of intake below which deficiency signs exist. This, however, is difficult, time consuming, and yet not without limitations.

Another method which has often been used is to maintain volunteers on diets which provide known amounts of the vitamin and progressively decrease the quantities (deplation) and determine the level at which either clinical manifestations appear or a known function of the vitamin is impaired. The intake is again progressively increased (repletion) to determine the level at which the above symptoms are reversed. Though data obtained from such studies provide reliable and precise information, they are also time consuming and difficult to perform; also this cannot be done for all vitamins.

The minimal requirement of a vitamin can also be considered to be the level of intake necessary to replace the inevitable losses from the body due to metabolism and excretion. Urinary excretion of the vitamin alone in many instances will not be helpful, since the end products of vitamin metabolism are not always known and measurements often difficult. Vitamins labelled with radioactive isotopes have been used to measure turnover rates and metabolic losses in some instances.

Urinary excretion of the vitamin at different levels of intake and the amount of the vitamin excreted in urine following the ingestion of a known test dose have also been employed to determine requirements. This method however, would not be applicable to the fat soluble vitamins which are not excreted in urine.

Several but not all vitamins are stored in the body and this often makes it difficult to estimate daily requirements. Although tissue saturation levels and the amount of the stored vitamin have in the past been used to arrive at requirements, whether intakes needed to maintain saturated levels should be considered as requirement is still debated.

The biological availability of vitamins present in food is an important factor in arriving at dietary allowances. Availability of the same vitamin may vary from one food to another; also other dietary factors may modify availability. Knowledge in this area is limited, except perhaps in the case of β–carotene which is provitamin A and to some extent in the case of folic acid, which exists in food both as free folic acid and as polyglutamates.

Unlike in the case of the proximate principles, vitamins are lost to varying extent during storage, processing and cooking; the extent of loss depending upon cooking practices. Proper allowances have, therefore, to be made for such losses.

Vitamins are broadly classified into two major groups -- those which are fat soluble A, D, E and K, and those which are water soluble. These are the B-complex group of vitamins—thiamine (B_1), riboflavin(B_2), pyridoxine (B_6), niacin, folic acid and vitamin B_{12} and ascorbic acid (C).

VITAMIN A

Vitamin A is essential for normal vision, for maintaining the integrety of epithelial tissues and for a wide variety of metabolic functions. Considerable amounts of vitamin A can be stored in the liver and made available for use as the need arises. Although the role of vitamin A in the visual process is well known, its mechanism of action in other metabolic processes is as yet not well understood. One of the earliest manifestations of vitamin A deficiency is night blindness, and more severe deficiencies include ocular signs leading to blindness, particularly in young children.

Vitamin A in the human diet exists either as preformed vitamin A (retinol) or as β–carotene, which in the body is converted into vitamin A. Only foods of animal origin contain preformed vitamin A. Since β–carotene forms a major source of dietary vitamin A in many developing countries including India, the efficiency with which it is absorbed and utilised becomes important in translating β–carotene values into retional equivalents. Although the enzymatic conversion of one molecule of β–carotene to retional should theoritically result in two molecules of retinol, because of physiological inefficiency, the maximum conversion that has been shown in experimental animals is around 50%. In addition, the efficiency of β–carotene absorption, is variable depending upon the food source. Based upon available evidence, the FAO/WHO Expert Group(8) has assumed that about one third of dietary

β-carotene is absorbed. As a result, a factor of 0.16 was used to convert β-carotene to retinol. In two studies carried out in India, one in adults (72) and the other in children (73), absorption of β-carotene from green leafy vegetables was found to be much higher, ranging from 50 to 99%. Similar figures were obtained for the absorption of β-carotene from other sources such as carrots and papayas. It would therefore, be more appropriate to use a factor of 0.25 (50% absorption and 50% efficiency of conversion) to convert dietary β-carotene into retinol—a factor which had been used by the earlier Committee. There is epidemiological evidence to support this contention (73, 74).

Among factors which can influence the absorption and utilization of β-carotene, levels of dietary protein and fat are believed to be important. At recommended levels of dietary protein and fat, absorption of β-carotene has been shown to be satisfactory (72, 75) in Indian subjects.

Requirement for Adults

The basis of the present day recommended allowances is the well known Medical Research Council study in England (76) done almost three decades ago in which it was found that defective dark adaptation which developed in human volunteers kept on vitamin A deficient diets was corrected by daily intakes of 390 μg of retinol. Higher intakes of 750 μg were, however, necessary to maintain serum vitamin A levels at satisfactory levels over long periods of time. Based on these observations both the FAO/WHO Committee (8) and the ICMR Expert Group (3) had recommended a daily intake of 750 μg of retinol.

Since then, more information has become available on the human requirements of vitamin A from the long term depletion study carried out in human volunteers in USA (77). In this study adults maintained on vitamin A deficient diets were found to develop impaired dark adaptation and abnormal retinograms when serum vitamin A levels fell below 30 μg/dl. Although intakes of 150 μg/day retinol corrected dark adaptation impairment, an intake of 600 μg/day of retinol appeared to be required for correcting electroretinogram changes. The 600 μg dose could maintain serum vitamin A at 20 μg/dl or above while intakes of 1200 μg were necessary to maintain serum vitamin A above 30 μg/dl. It would, thus, appear that 600 μg per day is needed to prevent all deficiency signs and to maintain satisfactory levels of circulating vitamin A. It is desirable to ensure a higher intake to provide for vitamin A stores to be built up. The dietary allowance of 750 μg/day recommended earlier appears adequate.

Pregnancy and Lactation

There have been no direct studies to quantitate the increase in vitamin A requirements during pregnancy and lactation. Vitamin A requirements during pregnancy have been calculated on the basis of the vitamin content of livers of the newborn. Additional intake of vitamin A required for this purpose is about 25 μg/day

throughout pregnancy. Since this constitutes a very small fraction of the recommended allowance for normal women, additional dietary allowance is not made during pregnancy.

The additional needs during lactation are calculated on the basis of vitamin A secreted in milk. The FAO/WHO Expert Group (8) has used an average milk secretion of 850 ml/day with a retinol content of 49μ/dl–a value observed in well-nourished populations and recommended an additional intake of 450μg vitamin A per day during lactation.The Committee felt that a figure of400μg can be adopted for Indian nursing mothers in keeping with the intake allowanced for infants below 6 months. The mean vitamin A content of breast milk of Indian women has been reported to be 21 μg/100 dl. These women, however, were known to consume diets which were deficient in vitamin A.

Infants and Children

In the absence of direct evidence, recommended intakes for infants and children are calculated on the basis of vitamin A intake through breast milk for infants and extrapolated values for children. Daily intake of vitamin A by Indian infants through breast milk is about 140μg, during the first six months of life (51). Such infants grow well and do not have deficiency signs. It is however, possible that they are drawing on their reserves. This possibility is supported by the observation that children of such communities do develop deficiency signs later during early childhood. Intakes of 140μg/day, thus appear to be inadequate. On the basis of vitamin A ingested by breast fed infants in wellnourished communities, the FAO/WHO Expert Group (8) has recommended a daily allowance of 400μg retinol upto the age of six months.VitaminA requirents of the children of other ages has been computed from the requirement figures for infants (50μg/kg), and adults (12μg/kg) taking into account growth rates at different ages(8).On this basis,vitamin A requirement of children will be 250–300μg retinol/day. The incidence of vitamin A deficiency signs, high and serum vitamin A levels are generally low among Indian children whose dietary intake is less than 100μg. In a group of children receiving food supplements which provided a total of 300μg of vitamin A/day over a period of 6 months, serum vitamin A levels were found to be around 30μg/dl, and clinical signs of vitamin A deficiency were rarely seen (78). These data indicate that a daily intake of 300μg vitamin A will meet the requirements of preschool children. The Committee, therefore, recommended the retention of the earlier figures of vitamin A allowances for children suggested by the Expert Groups of FAO/WHO and ICMR.

Loss of Vitamin A During Storage and Cooking

Available data indicate that on an average, 50% of vitamin A is lost during storage and cooking under Indian conditions (3). Cooking losses of carotene, however, appear to be much lower. A loss of 15–20% of carotene was seen in vegetables stored at room temperature for 24 hours, while cooking losses were negligible.

Since most of the vitamin A source for the Indian population is in the form of β -carotene which is not susceptible to cooking losses as is performed Vitamin A, the Committee felt that allowance for cooking losses may not be necessary while recommending dietary allowances of vitamin A for Indians.

VITAMIN D

Vitamin D is intimately connected with the metabolism of calcium and phosphorus. It promotes the absorption of calcium from the intestine and helps in the mineralization of bone. Vitamin D is converted in the body into 25 hydroxy cholecalciferol, and 1:25 dihydroxycholecalciferol, which are the active metabolites. VitaminD exists in two forms—vitamin D_2 which is a synthetic compound,and vitamin D_3 which is the form in which it naturally occurs in animal tissues. Both compounds have equal biological activity in man.

Vitamin D can be obtained from two sources; through foods and from exposure of the skin to sunlight. Very few foods contain appreciable amounts of Vitamin D—fish, eggs, liver and butter; milk is a relatively poor source, unless fortified with the vitamin, and populations who do not include these dietary articles in their habitual diets, ingest negligible amounts of vitamin D through food. Vitamin D is readily synthesised by the skin after exposure to sunlight and the quantity synthesized depends upon the area of the skin exposed, duration of exposure, time of day of exposure and the extent of pigmentation. Vitamin D deficiency leads to rickets in infants and growing children and osteomalacia in adults. Dietary requirements of vitamin D are not really known since they vary with the extent of exposure to sulight.

Infants and Chidren

Vitamin D requirement has been extensively studied in infants in the West where the diet forms the major source of this vitamin. A daily intake of 100 I.U. of vitamin D has been found to prevent rickets and promote normal mineralisation of bone. Intakes of 300-400 I.U. per day permit maximum absorption and retention of calcium (79,89). On the basis of these observations, the WHO/FAO expert Group recomended intake of 400 I.U. vitamin D per day for infants and children (81).

This figure, however, may not be valid for children living in India because of the relative abudnance of sunshine which would reduce the need for dietary vitamin D.

The results of a study (82) designed to determine Vitamin D requirements of Indian children has shown that on habitual diets which provide about 200 mg of calcium and virtually no dietary vitamin D, about 20 % of dietary calcium was absorbed and when supplemented with 200 I.U. of vitamin D, the absorption more than doubled to 45%. Increasing the intake of vitamin D to 400 I.U. was not associated with further changes in calcium absorption, indicating that 200 I U. of vitamin D had promoted maximal calcium absorption. It is however, possible that amounts

less than this could have done so. A level of 200 I.U. of vitamin D may, therefore, be suggested purely tentatively as dietary allowances for Indian children. This, however, would be largely academic since it is extremely difficult to obtain these amounts from diets normally consumed in our country. The observations that a very great majority of Indian children do not consume foods containing vitamin D and that in spite of this very few children have signs of vitamin D deficiency show that much of their vitamin D requirements are met from sunlight and that dietary requirements are probably very small.

Normal adults

Little is known of the Vitamin D requirement of adults. Osteomalacia sometimes occurs in women and it responds satisfactorily to the administration of 100 I.U vitamin D daily. Although the WHO/FAO Expert Group has recommended an intake of 100 I.U. vitamin D per day for normal adults, it is most likely that their vitamin D needs are met completely through exposure to sunlight. Any recommendation would be arbitrary and Indian diets can provide very small amounts.

Pregnancy and Lactation

The requirements of vitamin D for women may be higher during pregnancy and lactation when calcium metabolism is under physiological stress. Actual requirements are not known; but the FAO/WHO Committee (81) has recommended an intake of 400 I.U. vitamin D during pregnancy and lactation. In the absence of any experimental data, as in the case of normal adults any figure which may be suggested would be arbitrary.

VITAMIN C

Although most species of animals can synthesise vitamin C, man cannot do so and needs to get his vitamin C, therefore, through diet. The functions of vitamin C include its role in the synthesis of collagen, wound healing, aminoacid and carbohydrate metabolism and synthesis of some hormones. It also has an influence on the metabolism of iron. It has been claimed that the ingestion of very large amounts of ascorbic acid can beneficially influence common colds. There is, however, no unanimity on this aspect and the effect, if any is clearly not related to its normal physiological function but to a pharmacological drug like action. Deficiency of ascorbic acid leads to the development of scurvy, most often seen in infants and rapidly growing children. Vitamin C is present in high concentrations in leafy vegetables and citrus fruits. Many other commonly consumed fruits such as tomatoes and bananas and vegetables such as potateos contain useful amounts. The Vitamin is readily destroyed by oxidation during storage and cooking at high temperatures. As practised in Indian households, cooking losses from vegetables have been found to vary widely ranging from negligible quantities to as high as 80% of that originally contained (83). During storage, losses have been found to vary from 8% to 35%, depending upon the

vegetable and the way it is stored (84). For practical considerations, it may be assumed that about half the vitamin C content of the raw food is lost during storage and cooking. Vitamin C in Indian diets is contributed to a very large extent from cooked vegetables and only a small proportion is derived from raw vegetables and fruits--an observation that has considerable relevance in recommending dietary allowances for the vitamin. The requirement figure has to be doubled.

Although ascorbic acid has long been known to prevent scurvy, the explicit biochemical functions of this vitamin still remain unclear. Consequently, it has not been possible to develop satisfactory and reliable biochemical procedures to assess vitamin C nutritional status. Indirect information concerning the adequacy of this nutrient such as that derived through the measurement of ascorbic acid levels in plasma, leukocytes and urine are utilised to assess requirements.

Adults

The minimum requirement of vitamin C has been determined by controlled human experiments. Studies carried out by the Medical Research Council, UK have shown that the minimum amount of ascorbic acid needed to prevent or cure scurvy is about 10 mg daily (85). More recent observations in human volunteers have confirmed these findings (86, 87). These studies have also shown that although urinary levels of vitamin C fall rapidly after vitamin C intakes are drastically lowered, clinical signs of scurvy do not appear until the body pool of the vitamin is reduced to less than 30 mg. The administration of measured amounts of vitamin C showed that 6.5 mg/day was the absolute minimum needed to cure the disease.

There are several studies on the urinary excresion of vitnmin C and response to load test in Indian subjects (88,89). Although these tests provide some data on the adequacy of vitamin C intakes, they do not provide information which can be used to base the requirements on.

Concentrations of ascorbic acid in plasma or blood are poor indicators of vitamin C status. It is now accepted that concentration of the vitamin in circulating leucocytes reflect tissue concentrations. Vitamin C requirements of Indian adults were determined based on the intakes necessary to maintain the concentration of the vitamin in leucocytes at saturation level (90). After saturating the leucocytes with large doses of the vitamin, it was observed that in some subjects intake of 10 mg/day was sufficient to maintain these levels while in some others levels tended to decline. When the intake was raised to 20 mg, however, concentrations of Vitamin C in leucocytes could be maintained as saturation level for as long as100 days. Making an allowance of 20 % for individual variation the ICMR had earlier recommended (3) an intake of 25 mg vitamin C/day for the adult. The present Committee, however felt that there is no need to make allowance for individual varaition since an intakeof 20 mg of vitamin C was sufficient to maintain the ascorbic acid levels in all the

subjects studied. Taking into account that about 50% of vitamin C is lost in cooking the revised figure for dietary allowance of vitamin C is 40 mg per day.

Pregnancy and Lactation

There are no data to indicate that vitamin C requirement is increased during pregnancy. The increase due to foetal requirement may be small. Therefore, extra allowances may not be necessary since the allowance for normal adults includes a sufficient safety margin. The Committee accepted the recommendation made earlier that no additional allowances need be made for pregnancy.

The additional needs during lactation are calculated on the basis of vitamin C secreted in milk. Studies in Indian women have shown that they secrete about 600 ml milk per day with an average ascorbic acid content of 2.6 mg per dl (51). Based on these observations, the ICMR had recommended an additional intake of 15 mg vitamin C per day during lactation. The present Committee, however, accepted an average milk yield of 850 ml per day observed in wellnourished populations and recommended an additional dietary intake of 40 mg vitamin C per day during lactation. In both pregnant and lactating mothers, data obtained on the amount of ascorbic acid needed to maintain concentrations of vitamin C in leucocytes may help in fixing additional needs.

Infants and Children

On the basis of vitamin C ingested by breast fed infants in wellnourished populations, the WHO/FAO Expert Group (81) has recommended an intake of 20 mg vitamin C per day for infants, while the ICMR Committee recommended an intake of 15 mg per day, based on studies in India. The present Committee, however, felt that the requirements should be based on observations made in wellnourished population and therefore, recommended daily intake of 20 mg vitamin C for infants and 40 mg for children.

B-COMPLEX VITAMINS

Thiamine

Thiamine - pyrophosphate functions as a coenzyme for cocarboxylase which is intimately involved in carbohydrate metabolism; as a result, it has long been recognised that requirements of this are related to energy intake, particularly to energy derived from carbohydrates. The oxidative phosphorylation of pyruvic acid is dependent upon thiamine; in the absence of adequate thiamine, tissue levels of pyruvate increase. Thiamine is also needed for the activity of enzyme-transketolase and the activity of this enzyme in red blood cells falls in thiamine inadequacy : an observation which has in recent years been used to evaluate human thiamine requirement.

Deficiency of thiamine if prolonged leads to beri beri. Two types of the disease are known; the dry type characterised by nerve involvement— peripheral neutritis; and the wet type characterised by heart involvement—cardiac beri beri. The disease which used to be endemic in several parts of India three decades ago appears to be on the wane now for reasons not fully understood. Thiamine requirement is closely linked with energy intake and in presence of energy deficiency thiamine deficiency may not show up despite dietary deficiency of the vitamin.

In the habitual Indian diets, cereals form the major source of thiamine. In the rice eating population, this is the single most important dietary article which provides thiamine. Since the vitamin is both water soluble and heat liable in alkaline solutions considerable amounts are lost during cooking. Retention of thiamine has been found to vary between 30 and 80% of the original amount in several Indian preparations (91). In several vegetables, cooking losses have been found to be around 40% (92). From rice, loss of thiamine is much higher during washing than cooking. On an average, almost one half of the vitamin present in raw foods is lost during processing and cooking as practised in Indian homes.

Requirements of Adults

Diet survey data do not help in assessing the intake of thiamine by population groups since these have not been corrected for losses that are known to occur during cooking. There is evidence, however,that clinical signs of thiamine deficiency develop at dietary intakes of 0.12 mg per 1000 kcals or less of the vitamin (93,94,95). In outbreaks of beri beri, intakes through food have been found to be between 0.24 and 0.35 mg per 1000 kcals per day (96), although levels at or above 0.35 mg per kcal have been found to be compatible with good health.

Urinary excretion of the vitamin has also been used to assess minimum requirements. In Indian adults the urinary excretion of thiamine shows wide variations with the result that the correlation between intake and excretion is very poor. Many healthy individuals who have normal pyruvic and lactic acid levels in blood, however, had intakes around 0.4 mg per 1000 kcals and a urinary excretion of over 100 μg (97).

Thiamine requirements have been systematically studied in Indian adults. The Nutrition Expert group of the ICMR in 1968 (3) recommended thiamine intake as 0.5 mg per 1000 kcal based on evidence of urinary excretion of the vitamin in relation to dietary intake (97, 98) as well as depletion--repletion study in young women (99). In the depletion study, it was observed that the activity of the enzyme transketolase tended to plateau at intakes close to 0.2 mg per 1000 kcals. At that level the urinary excretion of thiamine in relation to dietary intake showed a sharp linear increase, suggesting that 0.2 mg per 1000 kcal was the requirement. Allowing for variation and cooking loss of 50 % (since cooked food was analysed in the

depletion-repletion study), the dietary allowance for thiamine would be 0.5 mg per 1000 kcal. Similar depletion–repletion studies in adult men, however, has indicated a higher requirement of 0.3 mg per 1000 kcals (99). However, in view of the fact that most countries and FAO/WHO recommended intakes of 0.4 – 0.5 mg 1000 kcals, and the observation that even biochemical evidence of thiamine deficiency is not frequent among Indians, the present Committee suggested that the earlier recommendation of 0.5 mg per 1000 kcals be retained.

Pregnancy

There are very few studies which have directly measured thiamine requirements of pregnant women. In the absence of adequate information on thiamine requirements of pregnant women, the committee agreed with the earlier recommendation that RDA may be fixed at 0.5 mg per 1000 kcal and that the total daily intake be related to their calorie allowance.

Lactation

The thiamine in breast milk secreted by Indian women as reported by various workers is below 15 μg per 100 ml (51,100,101). These figures relate to women who belong to poor income groups. The maximum concentration which could be achieved in milk through large supplements of thiamine given to the mother was 20 μg per 100 ml (102). At this concentration, with an output of 850 ml of milk, 0.17 mg of thiamine would be lost by the mother. Energy allowances are markedly increased during lactation and the additional intake of thiamine through increased food intake to meet the energy needs would more than meet this extra demand. Dietary allowances for thiamine for lactating mothers may, therefore, be computed on the basis of their energy allowancc i. e. 0.5 mg per 1000 kcals.

Infants and Children

Thiamine requirements of infants upto six months of life can be calculated on the basis ef the amount of vitamin ingested through breast milk. At a concentration of 20 μg per 100 ml and a volume of 850 ml of milk, the intake would be 0.17 mg per day. This would work out to 0.3 mg per 1000 kcals and since no losses occur, solely breast fed Indian infants who grow satisfactorily (31) get about 90 μg of thiamine per day at the age of six months, which corresponds to about 250 μg per 1000 kcals. At a maximum concentration of 20 μg per 100 ml and a volume of 850 ml of milk, intakes would be 0.3 mg per 1000 kcals. In the case of infants figures for requirement and recommended allowance would be similar since there are no dietary losses.

There are no studies on thiamine requirements of children. As the earlier Committee had done, it was recommended that allowances for thiamine for children be made on the basis of 0.5 mg per 1000 kcals similar to that for adults.

RIBOFLAVIN

Riboflavin is part of flavoproteins which are intimately connected with biological oxidations. It plays an important role in maintaining the integrety of mucocutaneous structures.

Among rich sources of riboflavin are flesh foods, legumes, green leafy vegetables and groundnuts. Although heat stable, riboflavin is destroyed when exposed to light. Cooking losses of riboflavin in Indian preparations are considerable ranging from 15 to 100 % depending upon the food and the type of cooking (9,103). It has, however, been found that the loss of riboflavin from commonly used legumes during cooking is negligible : a fair amount of riboflavin is derived (104). from such common legumes. A mean figure of 20 % loss for the whole diet as consumed may be considered while recommending allowances.

Deficiency of riboflavin is widespread in India and among clinical manifestations are cheilosis, angular stomatitis, naso-labial dyssebacia and scrotal dermatitis. Angular stomatitis is considered to be pathognomonic of riboflavin deficiency; it is now known that this lesion is not always due to riboflavin deficiency and when it occurs alone, may have a different etiology. In the past riboflavin requirements were expressed in terms of protein intakes and now they are expressed in terms of energy intakes. Because of the close interrelationship between the two, allowances computed on the basis of either are essentially similar.

Requirements for Adults

As in the case of thiamine, data on riboflavin intakes from diet surveys do not help in fixing requirements accurately, since intakes vary over a wide range and the extent of cooking losses are not known. Clinical signs have rarely been seen in adult subjects whose diets contain riboflavin upto 0.35 mg per 1000 kcals (105,106). However, clinical signs have been produced in man by maintaining volunteers on diets which provide 0.25 mg per 1000 kcals or less, at intakes of 2000 kcals daily (107,108). Both the urinary excretion of riboflvin and the concentration of the vitamin in blood cells have been used to determine requirements. In addition intakes of riboflavin which are necessary to maintain saturated levels of the enzyme - glutathione reductase in erythrocytes (EGR) (an enzyme which has riboflavin as a co-factor) have also been determined (109). In Indian subjects (who had clinical signs of deficiency) urinary excreticn was below 50 μg/per day at intakes of 0.36 mg per 1000 kcals (based upon raw diet). In well-to-do subjects who had no clinical signs and whose intakes were 0.5 mg per 1000 kcals,exerction was over 160 μg/per day (110). Concentrations of riboflavin in red cells was 20 μg per 100 ml at higher intakes and only 12 μg/100 ml at lower intakes.

Results of two depletion-repletion studies in Indian subjects (109) have shown that riboflavin intakes of 0.5 and 0.7 mg per 1000 kcals were necessary to keep the EGR maximally saturated and may thus be considered as representing

requirement. The earlier ICMR Committee had recomended an allowance of 0.55 mg per 1000 kcals as the requirement, and making some allowance for cooking losses, the Committee recomended a small upward revision, placing it at 0.6 mg per 1000 kcals.

Pregnancy and Lactation

There are no specific studies on riboflavin requirements of pregnant women. There are, however, studies to show that urinary excretion of riboflavin tends to be lower in pregnant women. The earlier Committee had suggested that allowances may be computed on the basis of figures for non - pregnant subjects, since the extra allowances for energy would take care of the additional needs for riboflavin as well; this recommendation is similar to that of the FAO/WHO Expert Group(8). The present Committee also recommended a similar procedure.

The riboflavin content of breast milk of Indian mothers belonging to poor income groups has been found to be about 17μg per 100 ml (51,111). With daily supplements of riboflavin, the concentration could be raised to a maximum of 30μg per 100 ml (111). The amount of riboflavin lost through milk per day, at this concentration would be 0.25 mg and this extra amount has to be met through the diet. Additional intake of riboflavin through increased energy consumption would be 0.3 mg. The efficiency of utilisation of dietary riboflavin for incorporation as milk riboflavin is not known. The Committee, therefore, recommended that allowances for riboflavin be computed on the basis of 0.6 mg per 1000kcals as for normal subjects.

Infants and Children

In the absence of other data, the FAO/WHO Committee had recommended allowances similar to those of adults. The riboflavin intake of solely breast fed Indian infants of 0–6 months of age, who had grown satisfactorily was around 100 μg per day – corresponding to 0.25 mg per 1000 kcals (31,51). There are no data on intakes of riboflavin by normal Indian children. It was, therefore, suggested that allowances for children be computed on the basis of 0.6 mg per 1000 kcals.

NIACIN

Nicotinic acid and nicotinamide are generally termed as niacin. Nicotinamide is a part of coenzymes connected with glycolysis, tissue respiration and synthesis of fat. Niacin, however, has a special relationship with the essential amino acid – tryptophan in that it can act as a precursor of the vitamin in the mammalian tissues. Dietary tryptophan can thus spare niacin. In any consideration of niacin requirements, dietary niacin and tryptophan, therefore, should be taken together. Both energy and protein intakes regulate the efficiency of conversion of tryptophan

to niacin (112, 113) and it is generally accepted that in well nourished normal individuals 60 mg of tryptophan should be considered as equivalent to 1 mg of niacin (114). Dietary allowances are usually made in terms of niacin equivalents.

$$\text{Niacin equivalents (mg)} = \text{Niacin content (mg)} + \frac{\text{Tryptophan content (mg)}}{60}$$

Foods of animal origin are rich sources of both tryptophan and niacin. Cereals are satisfactory sources of niacin in Indian diets; although in some, the vitamin is present in a 'bound' form and therefore not available for absorption. Niacin is more stable than are other B-Complex vitamins, although some losses do occur during cooking. Based upon studies carried out on Indian food preparations (92,104) an average loss of 25% can be assumed. Deficiency of niacin leads to the development of pellagra which is seen in endemic form in some parts of India, where jowar (sorghum) is the staple.

Requirements for Adults

Results of diet surveys done in India show that the average intake of niacin is around 18 mg daily. Among predominantly rice eaters, intakes are much lower, values ranging between 5 and 11 mg perday and together with tryptophan diets provided about 6 niacin equivalents per1000 kcals (115). Pellagra is rarely seen among this population Load tests using nicotinic acid have shown that in subjects consuming 6.5 to 7.2 niacin equivalents per 1000 kcals, their niacin status was satisfactory (116). The niacin intake of subjects suffering from pellagra have, however, been found to be around 7.5 equivalents per 1000 kcals—an apparently adequate intake. These subjects consumed diets based almost exclusively on sorghum. It has now been demonstrated that sorghum has a high leucine-isoleucine ratio and that in this situation, the efficiency of conversion of tryptophan to nicotinamide nucleotides is impaired (117). The same is true of diets containing maize.

The FAO/WHO Expert Group (8) has recommended an allowance of 6.6 mg niacin equivalents per 1000 kcals for adults—a level applicable to Indian subjects also, except in the unusual situation where either sorghum or maize forms the sole or major dietary article.

Pregnancy and Lactation

Information on the niacin requirements during pregnancy is scanty. Based on the observation that the urinary excretion of metabolites of tryptophan is higher in pregnant women than in normals, following an oral load of tryptophan, it has been suggested that the conversion of the amino acid into niacin is more efficient during pregnancy. The increased energy allowances made for pregnancy would also provide niacin.

The nicotinic acid content of breast milk in Indian women ranges between 100 and150 μg per100ml (118) and the amount lost in a day would thus be between 0.9 and 1.2 mg, and together with the tryptophen content of milk, a total of 2.5 niacin equi-

valents may be lost. As in the case of pregnancy, the niacin intake during lactation will be higher because of the higher energy intakes which are recommended. The Committee, therefore, agreed with earlier recommendations that dietary allowances for niacin be fixed at 6.6 mg niacin equivalents per 1000 kcals both during pregnancy and lactation.

Infants and Children

In the absence of any information on the niacin needs of infants, children and adolescents, the Committee recommended that their dietary allowances be computed on the basis of 6.6 mg niacin equivalents per 1000 kcals as is done for adult subjects.

PYRIDOXINE

Three naturally occuring pyridines—pyridoxine, pyridoxal and pyridoxamine are collectively known as vitamin B_6 ; although the term 'pyridoxine' is usually used as being synonymus with vitamin B_6 , Pyridoxine is a cofactor for several enzymes connected with the metabolism of aminoacids. It is also believed to have a role in the production of antibodies.

Information on the vitamin B_6 content of foods is not as complete as for many other nutrients. However, meat, pulses and wheat are known to be rich sources while other cereals are fair sources of the vitamin. Fruits and vegetables are relatively poor sources. Data on the relative proportions of the three components of vitamin B_6 in various foods are limited. The extent to which processing of foods and cooking practices destroy vitamin B_6 depends largely on the food. In meat and milk, considerable amounts are lost, while in foods of vegetable origin, there are hardly any losses This appears. to be related to the form in which the vitamin is present in foods.

Vitamin B_6 deficiency in man can lead to peripheral neuritis, anaemia, glossitis and cheilosis, seborrhoic dermatitis. Since many of these signs and symptoms are also produced by deficiencies of other vitamins as well, the extent to which pyridoxine deficiency exists in India is not known.

Requirement for Adults

The assessment of vitamin B_6 nutritional status is usually made on the basis of several biochemical tests which include the urinary excretion of the vitamin and its major metabolic product – 4 pyridoxic acid, excretion of xanthurenic acid in urine following a tryptophan load and the determination of the activity of the transaminase in red blood cells.

Results of diet survey data in India have shown that daily intake of the vitamin may vary from 1.2 to 3.3 mg perday (119). At intake levels of 1.2 mg per day,

biochemical evidence of B_6 deficiency was present as judged by the excretion of pyridoxic acid, as will as xanthurenic acid after a tryptophan load. In subjects consuming around 1.9 mg of B_6 per day, no such evidence was seen.These findings suggest that the requirement is some where between 1.2 and 1.9 mg per day. There is some evidence that B_6 requirements may be related to protein intake. In a controlled repletion study, it has been observed that when dietary protein levels were raised from 30 g to 100 g daily, the requirement of pyridoxine increased from 1.25 to 1.4 mg a day (12). The average requirement of vitamin B_6 for adults would thus appear to be about 1.5 mg per day. Since cooking losses in habitual Indian diets are neglible,no allowances for losses need be made.

Pregnancy and lactation

During pregnancy women excrete reduced amounts of vitamin B_6, have lower plasma pyridoxal phosphate levels and show abnormal tryptophan load test. Recent studies show that more than 4 mg vitamin B_6 per day is required to maintain plasma PLP (121) The amounts of pyridoxine needed to correct these changes are large and cannot be met from dietary sources alone and there is little indication as to the minimal additional intake needed which is consistent with adequate correction of the deficiency. In the absence of these data, the Committee suggested that the recommendations of the Food and Nutrition Board of NRC, USA (122) be accepted for Indians, realising that these figures are somewhat arbitrary.

Infants and Children

Relavent data on which requirements for infants and children can be based are scanty, except those relating to the B_6 content of breast milk. The concentration of B_6 in breast milk secreted by women in the west is around 0.1 mg per litre. Similar information on breast milk of Indian mothers is not available. The level in breast milk is seemingly inadequate to meet the infant's requirements. However, B_6 is stored in the liver during foetal growth and is apparently drawn upon during early infancy.

FOLIC ACID

The primary biochemical function of folic acid is related to the transfer of single carbons in the synthesis of a number of metabolites in the body. Along with vitamin B_{12}, folic acid is connected with the synthesis of nucleic acid. After absorption, folic acid undergoes a series of metabolic conversions to its various coenzymic forms.

Folic acid is present in a wide variety of foods. Leafy vegetables, fruits and yeast are particularly rich sources. Cereals and pulses contain fair amounts; on an average, pulses, usually have almost twice as much of folic acid as cereals do. Folic acid is present either in the free form or in the conjugated form as polyglutamates

with different numbers of glutamic acid residues. The proportion of free and conjugated forms in different foods varies considerably. Before absorption, ployglutamates have to be broken down into smaller units by the action of conjugases present in the intestinal lumen. The extent of absorption of dietary folate is not known with certainty, because while free folic acid is well absorbed, polyglutamates are less well absorbed. The availability of folates from foods cannot therefore be predicted.

Studies on the actual availability of food folates are few. These have shown that while over 70% of that present in liver and egg is absorbed, between 60 and 70% of that in pulses and green leafy vegetables and about 50% of that in vegetables is available (123). Several dietary factors including fibre are known to modify folate availability. Studies with the use of radioactive synthetic polyglutamates have shown that 50% of the ingested amount will be available for coenzyme action irrespective of the form in which they are consumed (124).

Folic acid deficiency if prolonged and severe, leads to abnormal haemopoiesis leading to megaloblastic anaemia, which readily responds to the administration of the vitamin. The anaemia is, however, indistinguishable from the megaloblastic anaemia due to vitamin B_{12} deficiency.

Requirements

Diet survey data on Indian subjects show that predominantly cereal based diets provide about 70 μg of folic acid a day. Although megaloblastic anaemia is infrequent in these subjects, it cannot be assumed that this amount is sufficient to meet requirements, because of the concomitant widespread iron deficiency which can mask folate deficiency.

About 50 μg of crystalline folic acid can bring about complete haematological remission in all subjects with folic acid deficient megaloblastic anaemia. Similarly,50μg per day can prevent biochemical evidence of folate deficiency in subjects experimentally maintained on folate free diets (125). In a depletion – repletion study in Indian human volunteers, 75 μg of folate was adequate to maintain optimal concentrations of folate both in serum and red blood cells (125). This figure is considerably lower than the 200-260μg per day found in another study wherein satisfactory concentrations of the vitamin in red cells and satisfactory return of folate after a load were used as criteria of adequacy. The latter figure is high compared to that obtained in most other studies. In view of the lack of precise information about the bioavailabi-

lity of food folates, the earlier Committee had recommended a dietary allowance of 100 μg of free folate. The present Committee retained this recommendation although it is lower than that recommended by the FAO/WHO Expert Committee (81).

Pregnancy and Lactation

The requirement of folic acid during pregnancy is known to increase and the additional amounts needed have been estimated to range between 200 and 400μg per day. The earlier ICMR Committee (3) had recommended an additional allowance of 150–300 μg daily. Results of subsequent studies in Indian women have suggested that between 200 and 300μg of folates are needed to maintain plasma and red cell folate levels in the normal range during pregnancy (126). Birth weights of infants born to mothers who had received 300 μg folate a day during pregnancy were higher than those born to mothers who had received either 100 or 200μg daily. These findings suggest that pregnant women need 300μg of additional folic acid daily. It is difficult to provide this amount through food and the additional needs may have to be met through supplements of medicinal folate.

The folic acid content of breast milk secreted by Indian women is 1.6 μg per 100 ml (127) — a value lower than the 3.0μg reported from the west. At the higher level, the amount of folate lost by the mother would be about 25 μg a day. An additional allowance of 50μg of folate may, therefore, be provided during lactation.

Infants and children

Breast fed infants will receive about 25 to 30μg of folate daily. Most of the folate in both breast milk and cow's milk is available for absorption. Requirements for children are not known and has to be computed from interpolation of values for infants and adults.

VITAMIN B_{12}

As a component of several coenzymes, vitamin B_{12} has an important role in the synthesis of nucleic acids. Its metabolism is closely interrelated with that of folic acid.

Vitamin B_{12} is present only in foods of animal origin. Liver, meat, eggs and milk are good sources. Many bacteria can synthesize vitamin B_{12} and when the vitamin is present in vegetable foods, it is an expression of microbial contamination. Microflora present in the human large intestine synthesize vitamin B_{12}. Although it has been suggested that part of this vitamin B_{12} is absorbed by the host, the balance

of experimental evidence shows that this is not so. Drinking water, particularly when it comes from contaminated wells, may contain small but nutritionally useful amounts of vitamin B_{12}. The extent to which polluted environment and unsatisfactory personal hygiene contribute to vitamin B_{12} intake in rural areas of developing countries has been a matter of serious speculation since populations consuming diets based predominantly on foods of vegetable origin do not show evidence of widespread B_{12} deficiency.

Deficiency of vitamin B_{12} leads to abnormal haemopoiesis, leading to megaloblastic anaemia, as in the case of folic acid deficiency. In addition, neurological manifestations due to subacute combined degeneration of the spinal cord may also occur, though rare, in India.

Requirements for adults

Assessment of the daily requirements of the vitamin is complicated by the fact that liver can store considerable amounts of vitamin B_{12}. In adults such stores have been estimated to be around 1 mg. Long term studies using radioactive labelled B_{12} have indicated that 0.1% of the body stores is lost every day, suggesting that about 1 μg is needed to replace this loss (128, 129). Absorption of vitamin B_{12} from the intestine is dose dependent; while 70% of a 0.5μg dose of crystalline B_{12} is absorbed, only 30% of a 5 μg dose is absorbed. The extent of absorption of B_{12} from foods thus depends upon its concentration. Vitamin B_{12} is absorbed through an active process, which needs the presence of the 'intrinsic factor' in the small intestines.

Depending upon the method used, the requirement may be placed from as low as 0.1 μg/day to as high as 1 μg/day. 0.1 μg of the vitamin given parenterally has been found to be adequate to induce reticulocytosis in subjects with megaloblastic anaemia, indicating that this may be the minimal requiremement. However, for sustained responses, a higher amount of 0.5 μg is needed. Considered along with the data on turnover studies, human requirement of vitamin B_{12} appears to be between 0.5 and 1.0 μgper day. After making some allowances for cooking losses and the uncertainty about the extent of absorption of food vitamin B_{12}, a dietary allowance of 1 μg of vitamin B_{12} per day may be recommended.

Diet survey data on Indians suggest that mean intake of vitamin B_{12} is around 0.7 μg when flesh foods and milk products are included in the diet in modest amounts. Very large sections of the population, however, do not appear to consume any significant amount of the vitamin.

Pregnancy and lactation

There is little information on which to recommend the additional needs during pregnancy. On the basis of the B_{12} content of foetuses, it has been estimated that fetal demands may be of the order of 0.3 μg per day. The vitamin B_{12} content of breast milk in normal women is around 300 pg/ml and the amount of the vitamin secreted in milk per day is thus between 0.25 and 0.3 μg. An additional intake of 0.5 μg per day would thus cover the needs during both pregnancy and lactation.

Infants and children

Megaloblastic anaemia has been found in exclusively breast fed infants whose intakes of vitamin B_{12} were below 0. 5 μg (130). The mean concentration of the vitamin in the milk of mothers of such infants was 75 pg/ml. With intakes of about 0.2 μg, abnormal haemopoiesis is not seen. Daily allowance of 0.2 μg may therefore, be considered adequate. Recommendations for children can be made from interpolation of figures between 0.2 and 1.0 μg, depending upon the age.

Like the earlier ICMR Committee, the present Committee was aware of the fact that the average Indian diet which is largely based on foods of vegetable origin like cereals and pulses cannot provide any significant amounts of B_{12} and that only by the inclusion of animal foods such as milk, egg or flesh foods which are expensive can the situation be improved. It was for this reason that allowances for B_{12} which would meet at least the minimum requirement of this vitamin rather than the optimum intake were made. The recommended amounts by the Committee are much lower than those recommended by other countries.

TABLE - 7.1

Recommended dietary intakes of Vitamins

Group		Vitamin A Retinol (μg)	Vitamin A β-carotene (μg)	Thiamine (mg)	Riboflavine (mg)	Nicotinic acid (mg)	Vit. B_6 (mg)	Ascorbic acid (mg)	Folic acid (μg)	Vit. B_{12} (μg)	Vit. D (IU)
Adult :	Man	750	3000	1.4	1.7	19	2.0	40	100	1	
	Woman	750	3000	1.1	1.3	15	2.0	40	100	1	
	Pregnancy	750	3000	+0.2	+0.2	+2	2.5	40	300	1.5	
	Lactation	1,150	4600	+0.3	+0.3	+3	2.5	80	150	1.5	
Infants :											
	0–6 months	400					0.3	20	50	0.2	
	6–12 ,,	300	1200				0.4				
Children :											
	1–3 yr.	250	1000	0.6	0.7	8	0.6				
	4–6 yr.	300	1200	0.9	1.0	11	0.9				
	7–9 yr.	400	1600	1.0	1.2	14	1.2				
Boys	10-12yr.	600	2400	1.2	1.5	16	1.6				
	13-15yr.	750	3000	1.3	1.6	18	2.0	40	50-100	0.2 to 1.0	200
	16-18yr.	750	3000	1.4	1.7	19	2.0				
Girls	10-12yr.	600	2400	1.1	1.4	15	1.6				
	13-15yr.	750	3000	1.2	1.4	15	2.0				
	16-18yr.	750	3000	1.1	1.3	15	2.0				

Group	Particulars	Net calories (kcal)	Proteins (gm)	Calcium (gm)	Iron (mg)	Vitamin A Retinol (μg)	or β-carotene(μg)
Man	Sedentary work	2400	55	0.4-0.5	24	750	3000
	Moderate work	2800					
	Heavy work	3900					
Woman	Sedentary work	1900	45	0.4-0.5	32	750	3000
	Moderate work	2200					
	Heavy work	3000					
	Pregnancy (second half of pregnancy)	+300	+14	1.0	40	750	3000
	Lactation 0-6 months	+550	+25		32	1150	4600
	6-12 months	+400					
Infants	0-6 months	118/kg	2.0/kg	0.5-0.6	1.0 mg/kg	400	--
	6-12months	108/kg	1.7/kg			300	1200
Children	1-3 years	1220	22.0	0.4-0.5	20-25	250	1000
	4-6 years	1720	29.4			300	1200
	7-9 years	2050	35.6			400	1600
Boys	10-12 years	2420	42.5	,,	,,	600	2400
Girls	– do –	2260	42.1				
Boys	13-15 years	2660	51.7	0.6-0.7	25	750	3000
Girls	– do –	2360	43.3		35		
Boys	16-18 years	2820	53.1	0.5-0.6	25	750	3000
Girls	– do –	2200	44.0		5		

Intakes of Nutrients

Thiamine (mg)	Riboflavine (mg)	Nicotinic acid (mg)	Vitamin B_6 (mg)	Ascorbic acid (mg)	Folic acid (μg)	Vitamin B_{12} (μg)	Vitamin D (I.U.)
1.2	1.4	16					
1.4	1.7	19	2 0	40	100	1	
2.0	2.3	26					
1 0	1.1	13					
1.1	1.3	15	2 0	40	100	1	
1.5	1.8	20					
+0.2	+0.2	+2	2.5	40	300		
						1.5	
+0.3	+0.3	+4	2.5	80	150		
+0.2	+0.2	+3					
59μg/kg	71μg/kg	780μg/kg	3.0	20	25	0.2	
54μg/kg	65μg/kg	710μg/kg	0.4				
0.6	0.7	8	0.6				
0.9	1.0	11	0.9				
1.0	1.2	14	1.2				
1.2	1.5	16					
1.1	1.4	15	1.6	40	100	0.2-1.0	200
1.3	1.6	18					
1.2	1.4	15	2.0				
1.4	1.7	19					
1.1	1.3	15	2.0				

Footnote to the Table on daily allowances of nutrients for Indians

1. Energy

(a) Energy allowance for heavy work does not include work under special conditions like high altitude.

(b) Energy allowances for children and adolescents are for normally growing healthy Indian children. No correction for actual body weights of other children need to be made; only the age is to be considered.

2. Proteins

(a) Adult allowance corresponds to 1 gm per kg of dietary protein of NPU 65.

(b) Infant allowance during 0–6 months is in terms of milk proteins. During 7–12 months, part of intake will be in the form of milk and supplementary feeding will be derived from vegetable proteins. Total daily protein allowances during infancy will be :—

0–3 months	2.3 gm/kg
3–6 ,,	1.8 gm/kg
6–9 ,,	1.8 gm/kg
9–12 ,,	1.5 gm/kg

(c) Allowances for children and adolescents have been computed using body weights as obtained in the well–nourished groups, and assuming NPU of 65 for the dietary proteins.

3. Calcium

(a) In the absence of precise information on calcium requirement of different groups a range of allowance has been suggested.

(b) Calcium allowance for infants 0–6 months will be for artificially fed infants. Calcium intake from breast milk will, however, satisfy the needs of breast–fed infants upto 6 months.

4. Iron

(a) This allowance of 32 mg iron is for adult women during her premenopausal period. For the post–menopausal woman, iron allowance is the same as for man.

(b) This allowance for pregnant women will be throughout pregnancy.

5. Vitamin A

Dietary allowance for vitamin A is given in terms of retinol (vitamin A alcohol) and β–carotene. Either of these is used, depending upon the dietary sources of vitamin. The factor to be used to convert β–carotene to retinol is :

$$1\ \mu g \text{ of } \beta\text{–carotene} = 0.25\ \mu g \text{ of retinol.}$$

If the diet contains both vitamin A and β-carotene, its content can be expressed as retinol, using the following formulae :

i. Retinol content μg = μg retinol + μg β-carotene $\times$ 0.25

if the retinol and β-carotene content of foods are given as μg in the food composition tables.

ii. Retinol content (μg) = vitamin A (I. U) $\times$ 0.3 + β-carotene (I.U) $\times$ 0.15 if the vitamin A and carotene values are given in terms of International Units.

6, 7, 8. Thiamine, Riboflavin and Nicotinic acid :

The daily allowances of these three vitamins are related to energy intake. The basic allowance per 1000 kCals are

Thiamine – 0.5 mg; Riboflavin – 0.55 mg and Niacin – 6.6 mg niacin equivalents.

Niacin allowance includes contribution from dietary tryptophan;

60 mg tryptophan being equal to 1 mg of nicain.

Niacin equivalents in a diet are computed as follows :

$$\text{Niacin equivalents (mg)} = \text{Niacin content (mg)} + \frac{\text{tryptophan content (mg)}}{60}$$

9. Folic acid

Dietary allowance of folic acid will be in terms of free folic acid (L. casei activity) present in foods.

The requirement of folic acid during pregnancy is about 300 μg per day. Since it is difficult to provide this amount through food, the additional needs may have to be met through supplements of medicinal folate.

10. Vitamin B_{12}

Vitamin B_{12} is derived entirely from foods of animal origin.

11. Vitamin D

Since the exact requirement of vitamin D is not known, an arbitrary allowance of 200 μg per day is made. This allowance is in addition to some amount of vitamin D that might be derived from exposure to sunlight.

12. Fat

Suggested intake of fat is given below :

	Fat* energy %	Essential fatty acids--energy %
Adult man and woman	20	3
Pregnant woman		4.5
Lactating mother		6
Infants		6
Young children	25	5–6

*About half of this, ie. 10% will come from invisible fat present in the foods.

8. BALANCED DIETS

The Nutrition Advisory Committee of the Indian Council of Medical Research had recommended dietary allowances for Indians in 1968. Based on these recommendations, balanced diets for various groups of individuals were suggested. Recommended dietary allowances have been updated by the 1979 Committee of ICMR. A new set of balanced diets based on the latest recommended dietary allowances has been formulated. In these formulations, some of the shortcomings of the earlier balanced diets have been overcome. In evolving these diets, cost factor has received adequate consideration. These least cost balanced diets have been arrived at by using linear programming*, after using appropriate constraints consistent with practical considerations. The constraints used in developing the present diets are listed below :

1. Energy derived from cereals to be not more than 75% of total requirements.
2. Ratio of cereal protein to pulse protein has been kept between 4:1 and 5:1.
3. Minimum level of leafy vegetables has been used.
4. Quantity of other vegetables has been kept to 80 g. or less and all vegetables put together to be no more than 150 g.
5. A minimum milk intake of 100 ml.
6. Energy derived from fat or oil not to exceed 15% of total calories.
7. Energy derived from refined carbohydrates (sugar or jaggery) has been kept around 5% and total calories from fat and sugar not to exceed 20%., and
8. Levels of food items suggested should be consumable by an average individual.

The currently suggested balanced diets offer the following improvements over the earlier ones :

(a) reduction in cost,

(b) reduction in amount of leafy vegetables which were found to be excessive,

(c) marginal reduction in bulk,

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* carried out by Mr. T. Ramnath, National Institute of Nutrition.

(d) the pulse content has been reduced, but the ratio of cereals to pulse proteins has been kept optimal and this has resulted in the total protein content being kept as close as possible to recommended dietary allowances, unlike in the earlier ones where protein content was much above the recommended dietary allowances, and

(e) the nutrient contents of these balanced diets have been kept as close as possible to the recommended dietary allowances unlike in the earlier recommended diets, wherein several of the nutrients were far in excess of recommended dietary allowances.

No separate diets have been suggested for nonvegetarians, but replacement of pulses by suitable quantities of egg, fish or meat has been suggested (from 50 to 100 %). For lactating and pregnant women, additional allowances of cereals, pulses, milk and fat have been suggested to meet the additional requirements of various nutrients.

The recommended balanced diets are given in Table 1. Additional suggestions for non-vegetarian diets are given in Table 2 and suggested additional allowances for pregnancy and lactation are given in Table 3.

Table 8.1
BALANCED DIETS

Food Item	Adult Man			Adult Woman			Children		Boys	Girls
	Seden-tary	Mode-rate work	Heavy work	Seden-tary	Mode-rate work	Heavy work	1 – 3 years	4 – 6 years	10-12yrs	10-12yrs
Cereals	460	520	670	410	440	575	175	270	420	380
Pulses	40	50	60	40	45	50	35	35	45	45
Leafy vegetables	40	40	40	100	100	50	40	50	50	50
Other vegetables	60	70	80	40	40	100	20	30	50	50
Roots and tubers	50	60	80	50	50	60	10	20	30	30
Milk	150	200	250	100	150	200	300	250	250	250
Oil and Fat	40	45	65	20	25	40	15	25	40	35
Sugar or Jaggery	30	35	55	20	20	40	30	40	45	45

Table 8.2

SUGGESTED SUBSTITUTION FOR NON-VEGETARIANS

Food item which can be deleted from non-vegetarian diets	Substitution that can be suggested for deleted item or items
50% of pulses (20 – 30 g)	1. One egg or 30 g of meat or fish 2. Additional 5 g of fat or oil.
100% of pulses (40 – 60 g)	1. Two eggs or 50 g of meat or fish or One egg + 30 g meat or fish 2. 10 g of fat or oil.

Table 8.3

ADDITIONAL ALLOWANCES DURING PREGNANCY AND LACTATION

Food items	During pregnancy	Calories (Kcal)	During lactation	Calories (Kcal)
Cereals	35 g.	118	60 g.	203
Pulses	15 g.	52	30 g.	105
Milk	100 g.	83	100 g.	83
Fat	--	--	10 g.	90
Sugar	10 g.	40	10 g.	40
	Total	293		521

APPENDIX

Estimation of protein and energy allowances at the national level

One of the practical applications of recommended dietary intakes is the asssesment or planning of national food supplies. Such an assessment is based on estimates of nutrient allowances at the population or national level, taking into account distribution of age, body weight and activity levels of the population. Estimates of requirements of protein and energy for Indian population based on the present recommended dietary intakes are given below: For these computations, the following procedure suggested by FAO/WHO Expert Group (1973) on protein and energy requirement has been used :

1. Per caput allowance of any nutrient is given by:

$$\overline{X} = \frac{\Sigma \; Wi \quad Xi}{\Sigma \quad Wi}$$

where Wi is the ith age group weightage (i. e. proportion of individuals in that population age group). Xi is the allowance of the ith age group, i. e., RDI of the specific nutrient (protein/energy).

$\overline{X}$ is the per caput allowance of the specific nutrient.

2. For the estimation of *energy* requirement, at the population level, the decrease in energy requirement with age is assumed to be as follows :

		% requirement
20 – 39 years	—	100
40 – 49 years	—	95
50 – 59 years	—	90
60 – 69 years	—	80
70 and above	—	70

3 In the absence of information on the proportion of adult population engaged in different levels of activity, it is assumed that the adults in age group 20–39 years in India are engaged in *moderate activity*, since over 70 % of the population are engaged in agricultural activities.

4. No allowance for climate is considered necessary since estimates of energy requirement of Indians are based on measurements of energy expenditure at the prevailing climatic conditions. The FAO/WHO Committee (1973)has also suggested that corrections for external temperature in estimating energy requirement is not necessary.

5. Allowances for lactating women are not given separately but have been included in the allowances for infants below 1 year of age as shown under item 8.

6. The proportion of pregnant women is estimated as follows : proportion of children under one year of age × 1.1

7. The proportion of lactating women is estimated to be approximately equivelent to proportion of children under 1 year assuming that majority of infants are breastfed at least for 1 year. Similar assumption has been made in recommending dietary allowances for lactating women.

8. Energy allowance for infants below 1 year is computed as follows :

0.5 × daily additional allowance of energy during the first 6 months of lactation [a]

+

0.5 × average daily allowance of energy for infants between 6 months – 12 months [b]

i. e. $0.5 \times (550 + 750) = 650$

9. Protein allowance of infants below 1 year is computed as follows :

0.5 × daily additional allowance of protein during the first 6 months os lactation + 0.5 × Average daily allowance of proteins for infants between 6 – 12 months.

$$0.5\,(25.0 + 12.0) = 18.5$$

10. No allowance for protein quality is considered necessary since in the recommended allowance for protein for Indians, the dietary protein quality is already taken into account. The per caput requirement of energy and protein for Indians based on 1971 census population structure are given in Table 1.

Total national requirement

= per caput requirement × total population

Food requirements :

The per caput requirement of foodstuff is one of the important considerations from the practical point of view in estimating the national food supplies. Employing the recommended balanced diets for various age groups, the per caput requirements of various food items are calculated on lines as described above under the following assumptions.

(a) To convert the per caput allowance at the physiological level to that at the retail level a tentative allowance of 10% is made for kitchen and other wastages.

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a) Assuming 50% of the child population is below 6 months of age and their energy and protein requirements are adequately met by the breast milk.

b) This is higher than the allowance for lactating women during 6 – 12 months hence this figure is used.

(b) To estimate production to meet the requirement of population an additional allowance of 12.5% is made for seeds and wastage during storage and transport.

Thus the per caput production to meet the recommended dietary intakes can be computed as follows :

Per caput production =
per caput allowance at the physiological level $\times$ 1.1 $\times$ 1·125

Per caput food requirement in India based on 1971 population census and recommended balanced diets are given in Table 2.

It must be pointed out that the estimated production of foods as given in the table (Table 2) can adequately meet the requirement of populations provided distribution of food is done according to requirement, and constraints of purchasing power do not limit consumption.

TABLE—1

Calculation of per caput intake level of energy and protein

Age group	Sex	Proportion	Recommended intake per day: Calories (Kcal)	Recommended intake per day: Protein (g)	Total requirement: Calories (kcal)	Total requirement: Protein (g)
Infants	–	3.2	650	18.5	2080	59.2
1 – 3 yrs	–	9.5	1220	22.0	11590	209.00
4 – 6 ,,	–	8.9	1720	29.4	15308	261.66
7 – 9 ,,	–	8.1	2050	35.6	16605	288.36
10 - 12 ,,	–	7.4	2340	42.5	17316	539.50
13 - 15 ,,	Boys	3.4	2660	51.7	9044	175.78
	Girls	3.3	2360	43.3	7788	142.89
16 - 18 ,,	Boys	3.1	2820	53.1	8742	164.61
	Girls	2.9	2200	44.0	6380	127.60
19 - 39 ,,	Male	14.5	2800	55.0	40600	797.50
	Female	14.2	2200	45.0	31240	639.00
40 - 49 ,,	Male	5 0	2660	55.0	13330	275.00
	Female	4.3	2090	45.0	8987	193.50
50 - 59 ,,	Male	3.3	2520	55.0	8316	181.50
	Female	2.8	1980	45.0	5544	126.00
60 - 69 ,,	Male	2.0	2240	55.0	4480	110.00
	Female	1.8	1760	45.0	3168	81.00
70 ,,	Male	1.2	1960	55.0	2352	66.00
	Female	1.1	1540	45.0	1694	49.50
Additional allowances during pregnancy		3.5	300	14.0	1050	49.00
Total	–	–	–	–	215032	4524.36
Per caput recommended intake		per day	–	–	2150	45.2

TABLE - 2

Per caput requirement of foods (gms/day) at the national level computed from the recommended balanced diets

Foodstuff	Physiological level	Retail level	Production level
1. Cereals	386	436	490
2 Pulses	43	47	53
3. Leafy vegetables	58	64	72
4. Other vegetables	45	49	55
5. Roots & tubers	40	44	50
6. Milk	200	220	248
7. Fats & Oil	31	34	38
8. Sugar/Jaggery	31	34	38

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